~~124~~

2054

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

OPERABLE UNIT 5

PROJECT-SPECIFIC PLAN FOR THE INSTALLATION OF THE SOUTH FIELD EXTRACTION SYSTEM

AUGUST 1995

U.S. DEPARTMENT OF ENERGY
FERNALD AREA OFFICE

000001

DRAFT

~~000013~~

~~124~~

2054

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

OPERABLE UNIT 5

PROJECT-SPECIFIC PLAN FOR THE INSTALLATION OF THE SOUTH FIELD EXTRACTION SYSTEM

AUGUST 1995

U.S. DEPARTMENT OF ENERGY
FERNALD AREA OFFICE

000002

~~000014~~

DRAFT

~~124~~
2054

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

OPERABLE UNIT 5

PROJECT-SPECIFIC PLAN FOR THE INSTALLATION OF THE SOUTH FIELD EXTRACTION SYSTEM

AUGUST 1995

U.S. DEPARTMENT OF ENERGY
FERNALD AREA OFFICE

000003

DRAFT

~~000045~~

TABLE OF CONTENTS

1.0 INTRODUCTION

This document presents the project specific plan (PSP) for the installation of eight Great Miami Aquifer groundwater extraction wells, pipelines and supporting equipment in the vicinity of the South Field area at the Fernald Environmental Management Project (FEMP), referred to in this plan as the South Field extraction system. A test well recently installed to support an aquifer pumping test will be converted to an extraction well to provide a nine-well South Field extraction system. Piping will be designed so that a 10th well could be added to the northeast corner of the system at a later date. The nine wells represent approximately one third of the baseline-case extraction well system evaluated in the Operable Unit 5 Feasibility Study (FS) (DOE 1995a, see Section F.7, Figure F.7-40) and proposed as part of the preferred remedy in the Operable Unit 5 Proposed Plan (DOE 1995b). These two documents were approved by the U.S. Environmental Protection Agency (EPA) on April 20, 1995 and the Proposed Plan was issued for public comment on May 1, 1995. The installation of the wells is being expedited in response to the possible availability of Fiscal Year (FY) 1995 and 1996 funds that can be used to gain an "early start" on the implementation of remedial actions for Operable Unit 5.

The wells will be situated around the South Field area, primarily along the storm sewer outfall ditch. Background on the selection of well locations is provided in Attachment E. This area was selected to accelerate the implementation of the preferred remedy for remediation of the Great Miami Aquifer because it contains the highest concentrations of uranium detected in the aquifer (up to 2100 parts per billion [ppb]) and represents the area with the longest potential remediation time.

The South Field extraction system will be comprised of 12-inch diameter stainless steel extraction wells, vertical turbine pumps, valve houses, an access roadway, electrical service, instrumentation, and approximately 5500 feet of buried high density polyethylene (HDPE) discharge piping (Figure 1-1).

The wellfield piping will be arranged in a two-header system with each well capable of discharging (through valving arrangements) to either header. Each well will have the capability to discharge to a header designated for treatment (i.e., the advanced wastewater treatment [AWWT] facility, South Plume interim treatment [SPIT] system, or the interim AWWT [IAWWT] units) or to a header directing flows to the Great Miami River.

A valve house will be constructed in the area where the wellfield headers cross the South Plume force main. Connections will be made between the force main and the wellfield headers so that the existing South Plume force main leaving the new valve house will carry the flow designated for treatment at

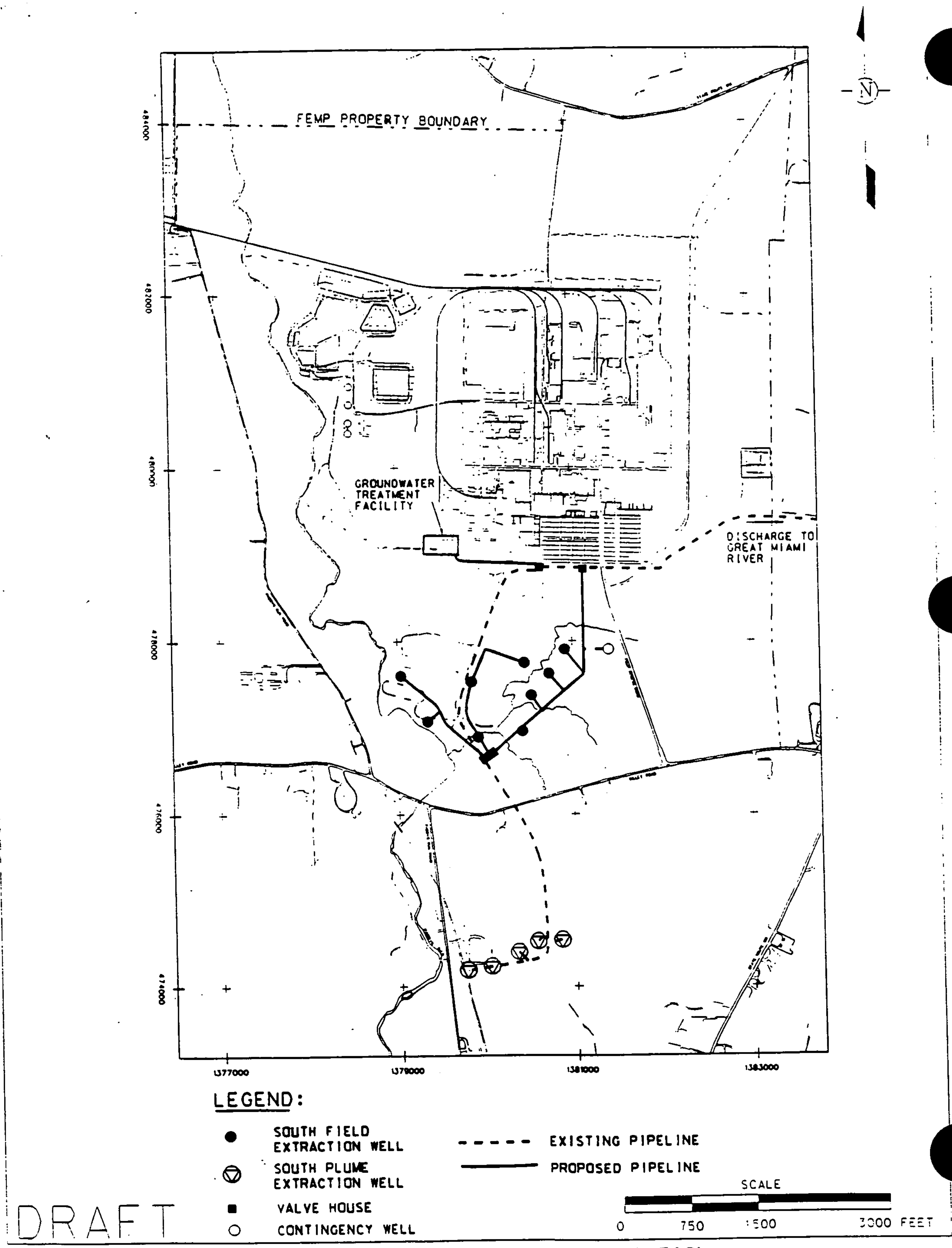


FIGURE 1-1. SOUTH FIELD EXTRACTION SYSTEM DESIGN

~~000018~~ 000006

AWWT, SPIT, and IAWWT and a newly installed wellfield header will carry flow designated for discharge to the Great Miami River.

The new wellfield header carrying flow for discharge to the Great Miami River will tie into the existing discharge force main between the east storm water retention basin and the south access road. The effluent from the South Plume system will be diverted at the new South Field valve house, combined with other flows and discharged to the Great Miami River. Additional details are provided in Section 4.2.

1.1 RESTORATION OBJECTIVES

The Proposed Plan for Operable Unit 5 has identified restoration of the Great Miami Aquifer to full beneficial use, including use as a drinking water source, as the primary remedial action objective for the aquifer. This objective applies uniformly to all affected areas of the aquifer (both on- and off-property) that contain FEMP-related contaminants.

Consistent with this objective, Safe Drinking Water Act proposed and final maximum contaminant levels (MCLs) have been adopted as final remediation levels (FRLs) for FEMP-related contaminants in the Great Miami Aquifer. For those FEMP-related contaminants that do not have an established MCL under the Safe Drinking Water Act, a concentration equivalent to an incremental lifetime cancer risk (ILCR) of 10^{-5} for carcinogens or a hazard index (HI) = 1 for noncarcinogens would be used as the FRL. The FRLs will be tracked throughout all affected areas of the aquifer and will be the basis for determining when the Great Miami Aquifer restoration objectives have been met.

These objectives apply to the preferred approach for restoring the Great Miami Aquifer, as presented in the Operable Unit 5 Proposed Plan and discussed below.

1.2 PREFERRED APPROACH FOR RESTORING THE GREAT MIAMI AQUIFER

The Proposed Plan for Operable Unit 5 has identified groundwater extraction and treatment as the preferred approach for restoring the Great Miami Aquifer. The FS concluded that a 28-well base-case extraction system pumping at a maximum of 4000 gallons per minute (gpm) would be sufficient to restore the aquifer in an estimated 27-year time frame. Background on the selection of these 28 well locations is provided in Attachment E. Portions of the recovered groundwater exhibiting the highest concentrations of contaminants would be treated through the existing treatment facilities and a future expansion of the AWWT facility. Contaminated groundwater would be treated to the design capacity of the AWWT facility, and more highly contaminated groundwater would be preferentially treated before treatment would be expended on less contaminated water.

The remaining portions of recovered groundwater exhibiting lower uranium concentrations will be blended with treated water to maintain a discharge to the Great Miami River at or below the discharge limits that will be set in the ROD.

The 28-well base-case extraction system evaluated in the FS revealed that conventional groundwater extraction and treatment technologies could satisfactorily restore the aquifer within the 27-year restoration period, which was identified through groundwater modeling simulations of restoration performance. As noted in the Proposed Plan, the process of restoring the aquifer is chiefly controlled by the chemical interactions that occur between the contaminants and the sand and gravel matrix composing the aquifer system. This process is complex and leads to significant uncertainty in the ability to precisely simulate and predict the performance of groundwater recovery operations. As part of the preferred alternative, the FEMP would continue to evaluate the benefits of applying emerging or innovative technologies to enhance contaminant recovery from the aquifer. These technologies could include the possible reinjection of groundwater less than 20 ppb into the aquifer as a means of speeding the contaminant flushing process.

The FEMP's evaluation of enhancement technologies will be incorporated into the remedial design process and, as necessary, into the periodic reviews of system operational effectiveness conducted during actual remediation. This is consistent with the performance evaluation strategies outlined in EPA's General Methods for Remedial Operation Performance Evaluations (EPA 1992). As envisioned in this guidance, efforts to promote system performance, assess technological advances, and improve system economics and efficiency should be extended throughout the life of the remedial action.

The FEMP is performing additional modeling simulations of the reinjection process and is planning to conduct a field-scale demonstration of the technology in FY 1996. If the need to apply reinjection or other enhancement technologies is deemed appropriate in the future, approval by EPA or Ohio EPA (OEPA) would be obtained before implementation.

1.3 RELATIONSHIP BETWEEN THE SOUTH FIELD EXTRACTION SYSTEM AND THE PREFERRED ALTERNATIVE IDENTIFIED IN THE PROPOSED PLAN

The wells to be installed under the South Field extraction system and the converted pumping test well are a subset of the extraction wells identified for the preferred alternative in the Operable Unit 5 Proposed Plan. They are being installed as a first-phase effort to accelerate implementation of the Operable Unit 5 remedy in the area of the aquifer exhibiting the highest uranium concentrations and the longest potential remediation time. The well locations were evaluated through the modeling simulations and performance evaluations conducted during the Operable Unit 5 FS. Placement of the wells at these locations will effectively capture the uranium plume in this area. Background on the selection of extraction well locations is provided in Attachment E.

A commitment to completing 9 of the 28 proposed extraction wells now will not jeopardize the FEMP's ability to accommodate the remaining wells or the potential for application of reinjection technologies at a later date, should reinjection be identified by DOE and EPA as a necessary enhancement technology. The necessary piping and utilities plans take into consideration the future expansion of the system.

1.4 PROJECT CONSTRAINTS

The installation of the South Field extraction system is being proposed as an early start on aquifer restoration activities. The project is being proposed at this time to most appropriately use available funding for the early completion of planned groundwater extraction systems. It is recognized that the installation of the system is in advance of required Amended Consent Agreement schedules for remedial design and remedial action for Operable Unit 5.

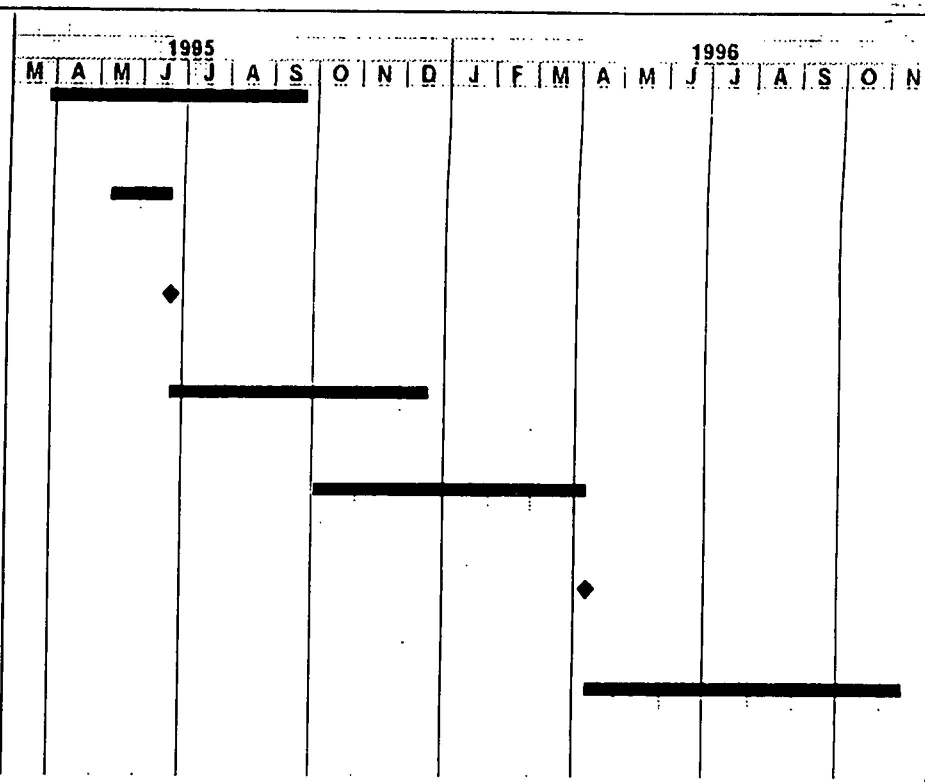
Implementation of the project is subject to funding availability. While efforts are being made to secure the necessary funding to expedite completion of the project, in the event funding is deemed unavailable the project will be delayed. Should funding not be available to expedite the installation of the nine-well extraction system, installation would be delayed with a final project schedule included within the Operable Unit 5 Remedial Design Work Plan. Upon incorporation into the approved RD Work Plan, the project schedule would be subject at that time to the enforcement provisions of the Amended Consent Agreement.

Figure 1-2 presents a preliminary schedule for the installation of the South Field extraction system. On the basis of this schedule, the systems would be expected to be available for operation on or before November 17, 1996. Efforts are underway to accelerate critical path items, such as construction contractor procurement, to expedite the overall project schedules. During the course of the project, documentation and/or design packages will be submitted to EPA for review. The following are the project deliverables anticipated to be submitted to EPA:

- Functional Requirements and Design Basis 5/19/95
- South Field Pumping Test Report 8/17/95
- 90 Percent Design Documentation 8/11/95
- Certified-for-Construction Design Drawings 10/2/95
- Well Completion Logs 4/15/96
- Operations and Maintenance Plan 1/15/96
- Status Reports Monthly with Amended Consent Agreement report

000009

Activity Description	Early Start	Early Finish
Design South Field Extraction System	27MAR95	21SEP95
Procure - Wellfield Contractor	11MAY95	22JUN95
Award - Wellfield Installation		22JUN95
Install - Wellfield Extraction System	23JUN95	20DEC95
Procure - Pipeline System Contractor	02OCT95	08APR96
Award - Pipeline System Installation		08APR96
Install - Pipeline System	09APR96	15NOV96



• Schedule based on availability of funding in FY 1995 and 1996.

FERMCO
Proposed Schedule
South Field Extraction System

FIGURE 1-2. FERMCO PROPOSED SCHEDULE FOR SOUTH FIELD EXTRACTION SYSTEM

The Operations Plan identified above would be submitted to develop a common operational philosophy between DOE and EPA regarding the extraction system . The plan would describe the current treatment capabilities of the FEMP, the characteristics of the discharges to the Great Miami River, and the anticipated impacts operation of the South Field extraction system would have on these discharges. Upon final approval by EPA, the Operations Plan would establish the operating constraints for the system, along with the overall monitoring requirements and strategy.

1.5 ORGANIZATION OF PROJECT-SPECIFIC PLAN

This PSP has been prepared in accordance with the requirements of the Sitewide CERCLA Quality Assurance Plan and is comprised of nine sections. The sections and their contents are as follows:

Section 1.0 Introduction - Includes a discussion of the purpose of the PSP, an overview of project objectives and scope, and the plan organization.

Section 2.0 Management and Organization - Includes a brief description of the organization of the project and the responsibilities of the key personnel or organizations.

Section 3.0 Background - Includes brief background information on the geologic, hydrogeologic and water quality conditions in the study area and on related existing extraction and treatment systems at the FEMP.

Section 4.0 Description of Project Activities - Includes a discussion on the design and placement of the well system, installation of the piping and support systems, well development activities, performance monitoring and the collection and analysis of samples to support well installation.

Section 5.0 Decision Points and Contingencies - Includes a discussion of key decision points and required flexibilities necessary to the project during well drilling and installation.

Section 6.0 Data Management And Analysis - Includes a brief discussion on the management of project data.

Section 7.0 Health and Safety - Establishes that a task specific health and safety plan will be issued and followed to support project activities.

Section 8.0 Quality Assurance/Quality Control - Includes a brief discussion on the overall quality assurance/quality control requirements for the project.

Section 9.0 References - Provides a listing of information referenced by the PSP.

2.0 MANAGEMENT AND ORGANIZATION

This section identifies the roles and responsibilities of key management and technical personnel associated with the completion of the South Field extraction system. The Amended Consent Agreement places ultimate project management responsibility with the DOE and the EPA. Additionally, the OEPA is participating in the cleanup process at the FEMP.

Figure 2-1 identifies the relationship among the regulators, DOE administrative and program management organizations, stakeholders, and the Fernald Environmental Management Corporation (FERMCO) and its subcontractors. Figure 2-2 depicts the flow of project communications that are in place for this project. The DOE Operable Unit 5 Team Leader will provide the overall programmatic direction for the accomplishment of the activities described in this PSP.

The FERMCO organization consists of project organizations, support divisions, and service departments. The support divisions provide discipline-specific personnel to staff the project organizations on a matrix basis. Service organizations provide resources and support to the project organizations on an as-needed basis.

Parsons is a subcontractor to the DOE providing a range of services to the FEMP including design engineering. Parsons will be responsible for the completion of all design-associated activities on this project.

It is envisioned that well drilling and construction activities necessary to complete the project will be provided by subcontractors to FERMCO. Following completion of necessary design activities, procurement packages will be issued for bid to qualified subcontractors. Following award, the selected contractor will be responsible for completing the project well-drilling or construction activities in accordance with issued design drawings and/or specifications.

Descriptions of some of the key technical responsibilities of project personnel or organizations are provided below.

The DOE Operable Unit 5 Team Leader is responsible for:

- Providing program direction and oversight to the completion of project activities
- Acting as the point of contact within DOE and for the regulators and stakeholders for all communications concerning this project.

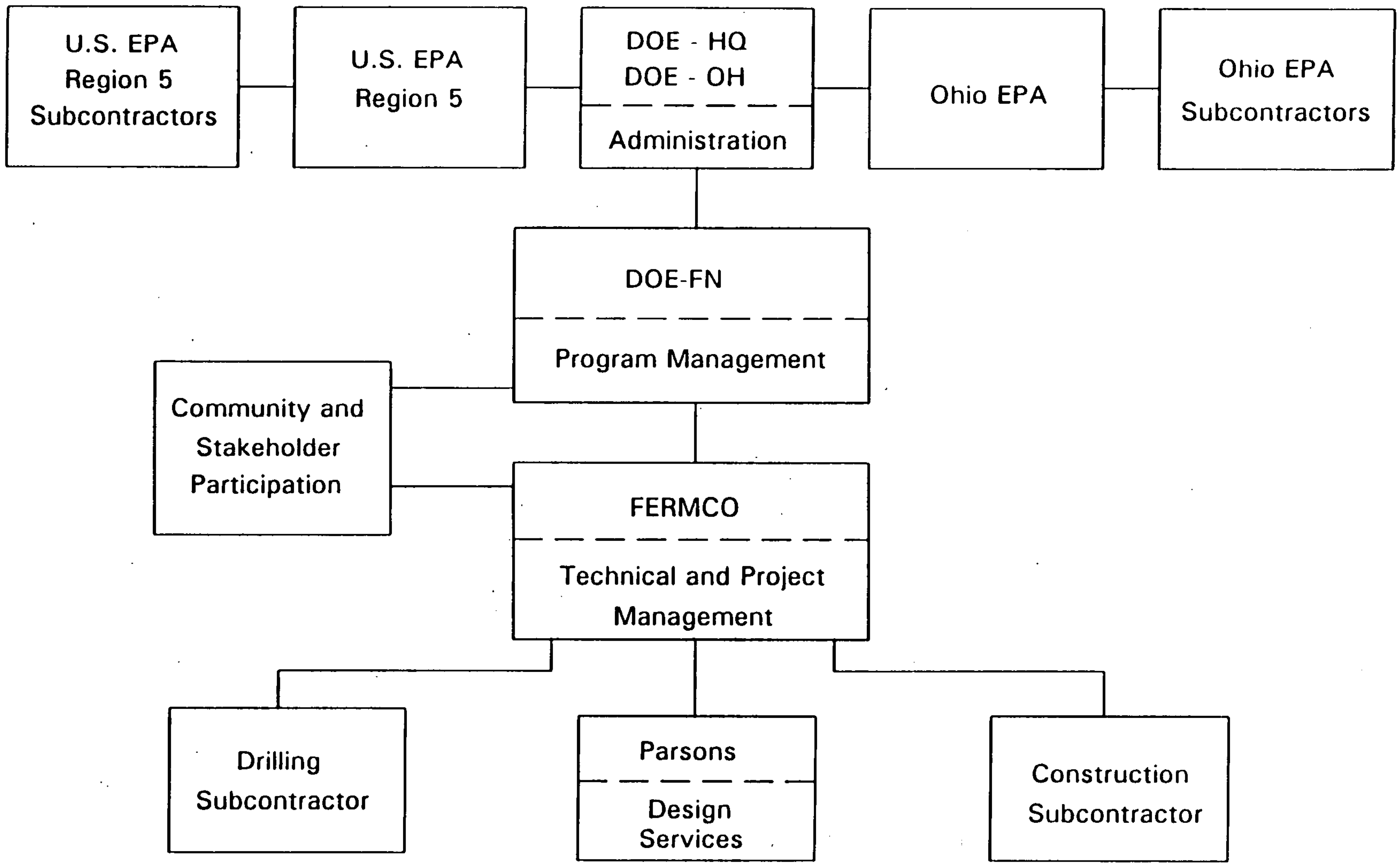


FIGURE 2-1. PROJECT ADMINISTRATIVE RELATIONSHIPS

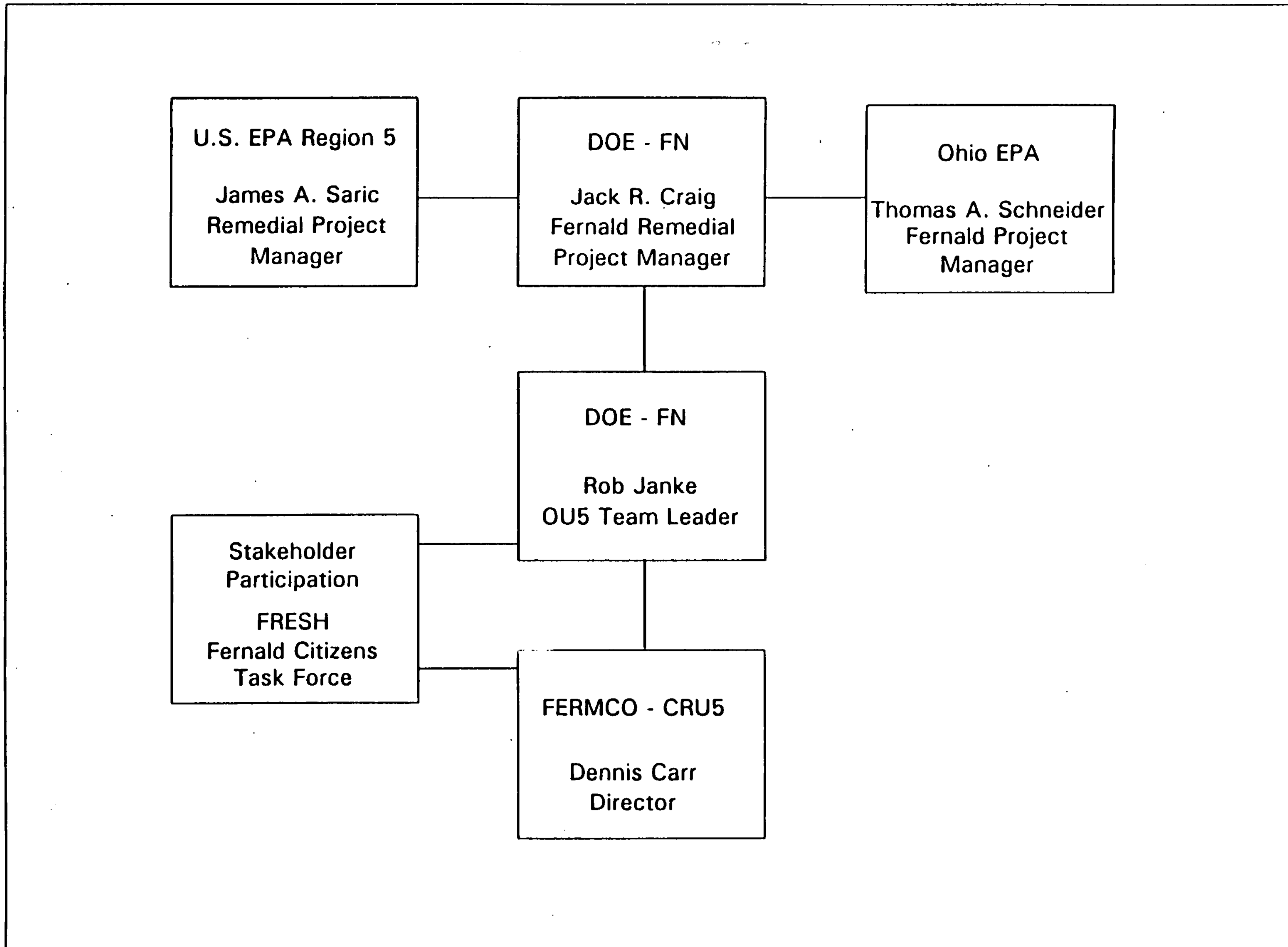


FIGURE 2-2. PROJECT COMMUNICATIONS FLOW CHART

The FERMCO Operable Unit 5 Director is responsible for:

- Providing overall project management and technical guidance to the FERMCO team
- Ensuring the necessary resources are allocated to the project for the efficient and safe completion of project activities
- Overseeing and auditing project activities to ensure that the project is being performed efficiently and in accordance with all regulatory requirements and commitments, DOE Orders, site policies and procedures, and safe working practices.

The FERMCO Project Manager is responsible for:

- The safe and prompt completion of project design and construction activities
- Oversight and programmatic direction of system startup and operation
- Providing a technical lead for the design of the system to ensure it attains project objectives
- Providing management oversight of the design and construction subcontractors to ensure project objectives are safely and efficiently attained
- Establishing and maintaining the project scope, schedule and cost baseline
- Reporting to the DOE Operable Unit 5 Team Leader and FERMCO Operable Unit 5 Director on the status of project activities and on the identification of any problems encountered in the accomplishment of the project objective
- Obtaining the necessary funding to complete the project.

The FERMCO Lead Geologist is responsible for:

- Reporting to the FERMCO Project Manager on the progress of drilling activities
- Documenting the geology of each boring
- Being present whenever a borehole is advanced, casing and screen is being installed, and during well-development activities
- Generating subsurface logs for each boring, generating a complete and accurate daily log of project activities, and preparing lithologic logs in the field
- Documenting lithology and depositional features.

The drilling subcontractor is responsible for:

- On-site operations of each drilling rig
- Completion of well installation
- Well development.

Parsons is responsible for:

- Completion of the engineering design of the project.

The construction subcontractor is responsible for:

- Completion of construction activities for the project including the installation of pumping and piping systems, utility tie-ins, and tie-ins to existing FEMP piping and treatment systems.

3.0 BACKGROUND

3.1 HYDROGEOLOGY OF THE DRILLING AREA

The hydrogeology of the drilling area has been characterized in detail in the Operable Unit 5 Remedial Investigation (RI) Report (DOE 1995c). The new extraction wells are to be located in the southwest corner of the FEMP property (Figure 3-1). This area is situated over the New Haven Trough, a large buried valley whose axis roughly extends in a northeast - southwest orientation (Figures 3-2 and 3-3). The New Haven Trough is bounded by Ordovician-age shale and limestone bedrock along the floor and walls. The trough was carved into the bedrock during the Pleistocene and subsequently filled with approximately 150 to 190 feet of sand and gravel in what was most probably a braided stream environment. Glacial processes during Wisconsin time deposited up to 60 feet of clay-rich glacial overburden over the sand and gravel outwash deposits.

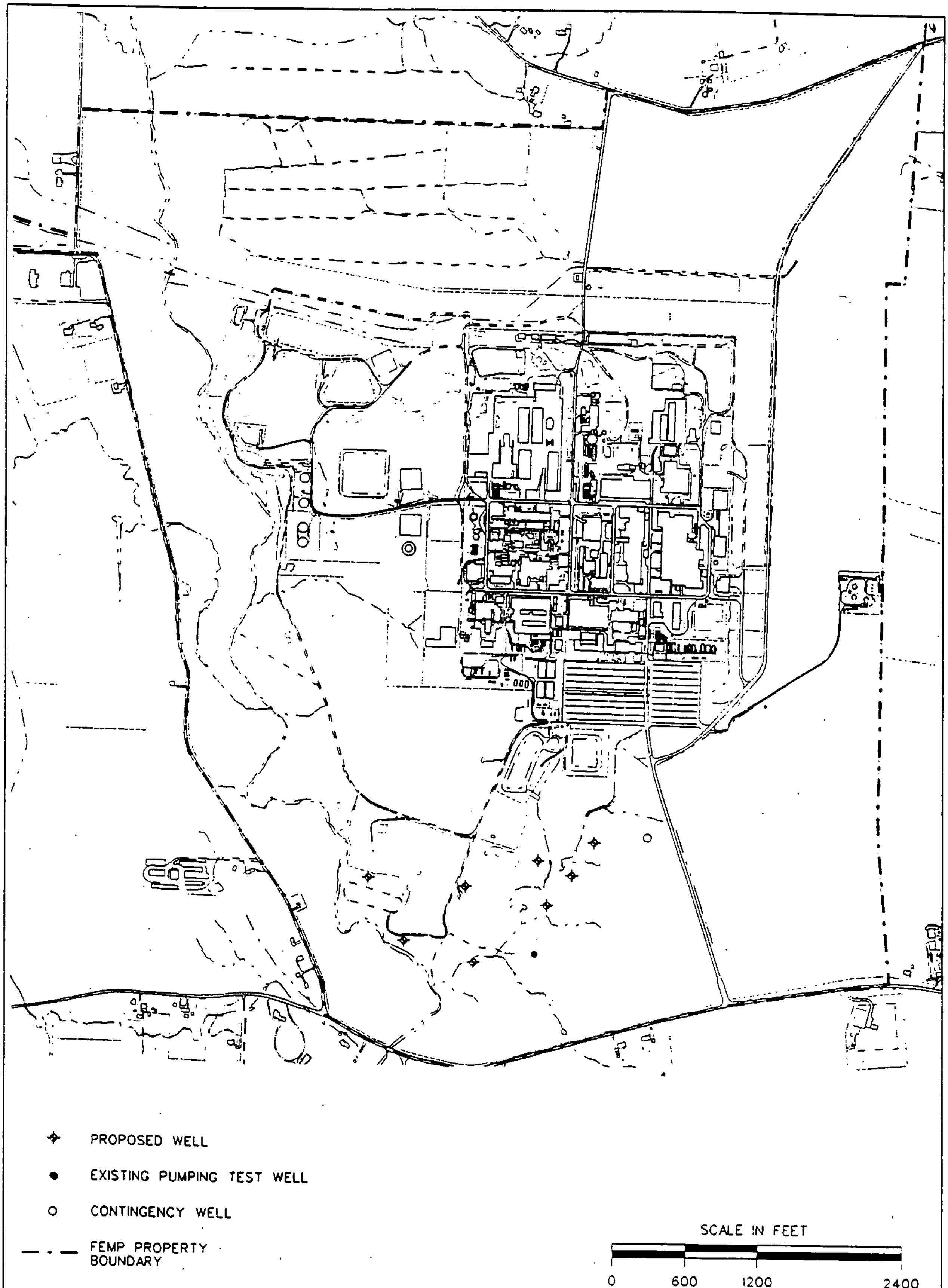
The depth to bedrock in the drilling area varies from approximately 165 feet to 195 feet. Approximately 3 to 12 feet of brown clay and 6 to 11 feet of gray clay exists in the glacial overburden. A semiconfining clay layer divides the aquifer into an upper and lower zone. The clay layer is not present at all of the locations (Figure 3-4).

Several years of water elevation data exists for the drilling area. Data collected in 1993 reveals that flow is either to the east or southeast depending on the seasonal influence of recharge from Paddys Run. The water table under the drilling area dips to the east in January and April (when water levels are high due to recharge from Paddys Run) and to the southeast in July and October (when water levels are low and Paddys Run is dry except during and immediately following significant precipitation). Quarterly water table maps for 1993 are provided in Attachment A. Data collected from Wells 2387, 3387, 2049, 3049, and 2390, and 3390 indicate that seasonally the water table rises and falls approximately 7 feet; from a low of approximately 518 feet above mean sea level (amsl) to 525 feet amsl. Hydrographs are provided in Attachment A.

3.2 WATER QUALITY OF THE DRILLING AREA

Water quality in the Great Miami Aquifer within the drilling area has been characterized in detail in the Operable Unit 5 RI Report (DOE 1995c). The predominant contaminant of concern for the area is uranium. Unfiltered samples collected from Type 2 wells in 1993 indicate that total uranium concentrations in the drilling area range up to 2070 ppb (DOE 1995c, Plate E-77). This

~~124~~
2054

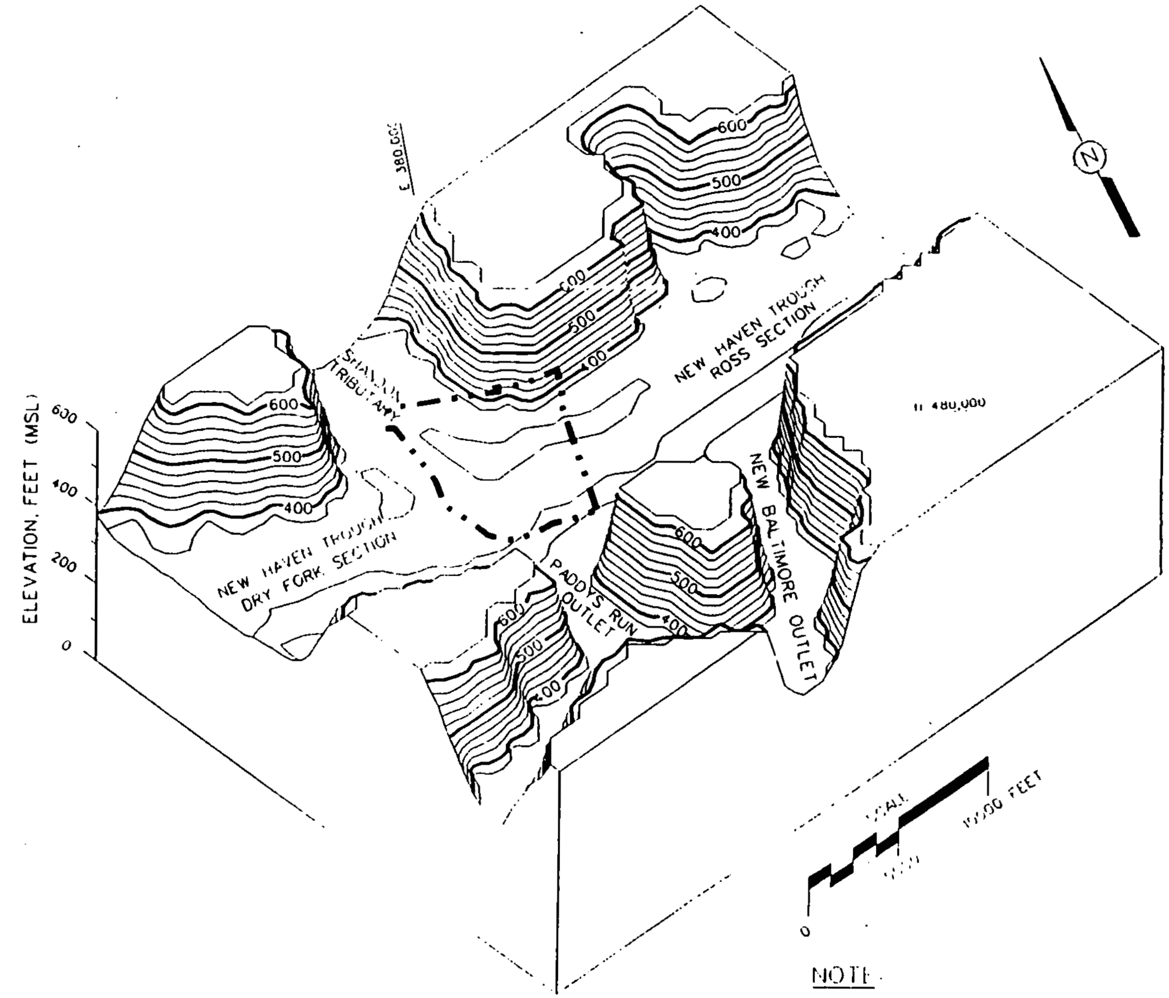


/5arn1/dgn/sf9welrev.dgn

000017

FIGURE 3-1.
LOCATION OF RECOVERY WELLS

000018



NOTE:
VERTICAL EXAGGERATION = 20X

FINAL

LEGEND:

400 CONTOUR

FEMP BOUNDARY

/USR/ERMA3/FMPC/10 … OUS RIDATA 6-10-94 STATE PLANAR COORDINATE SYSTEM 1927

FIGURE 3-2 3-DIM … NAL BEDROCK CONFIGURATION

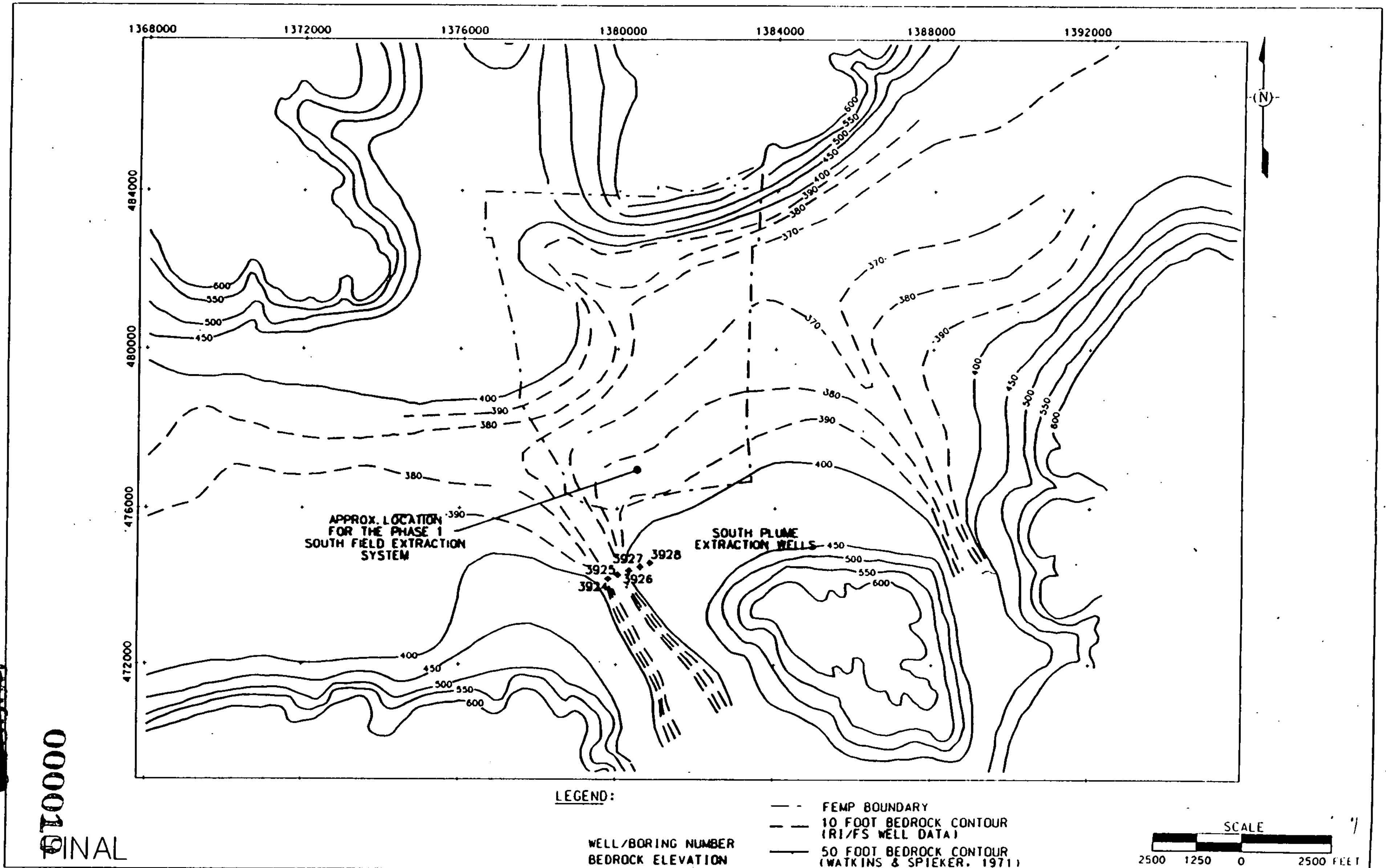


FIGURE 3-3. BEDROCK TOPOGRAPHIC SURFACE

2054

FINAL

000019

15

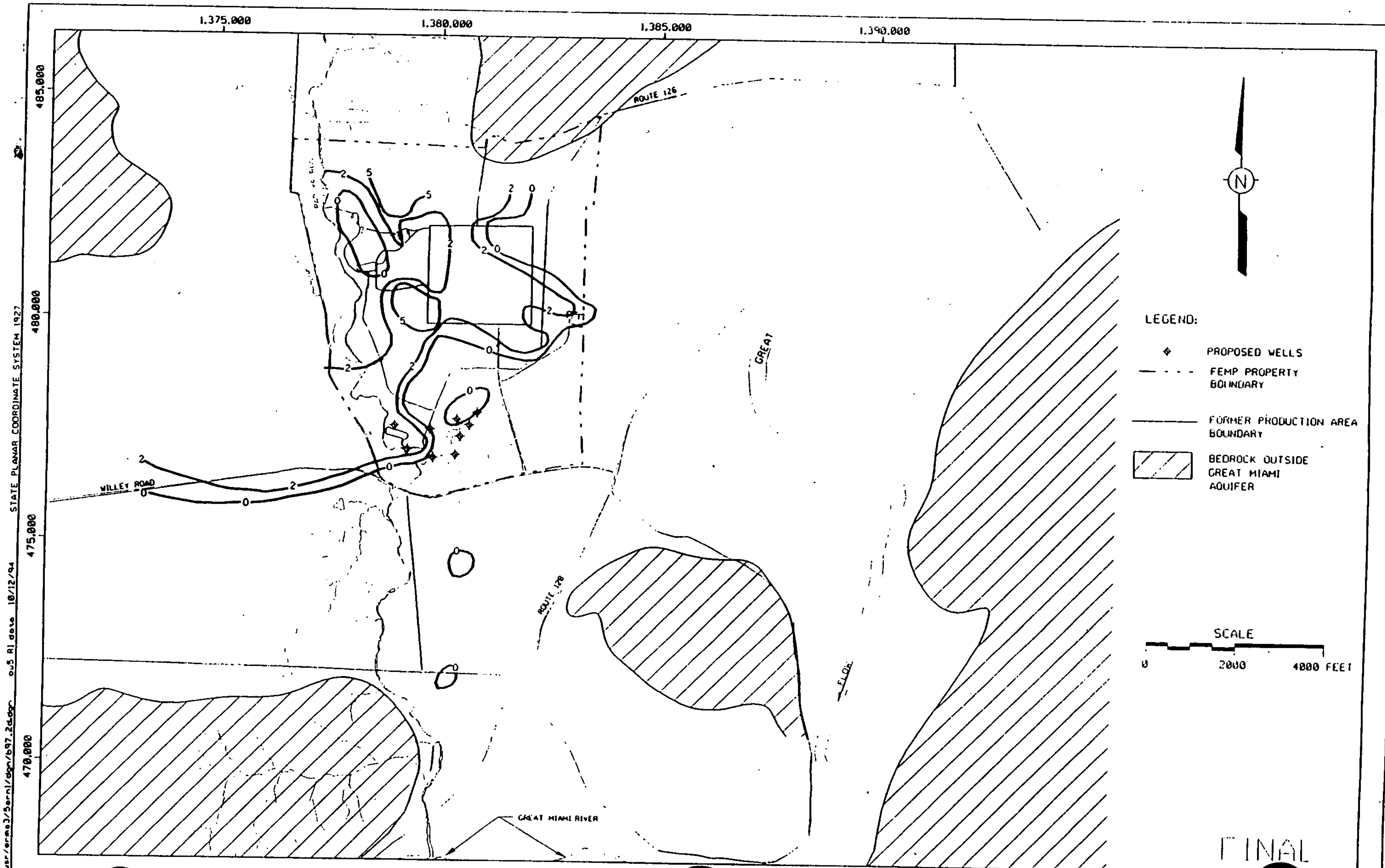


FIGURE 3-4. CLAY RBED ISOPACH

000020

concentration was found in Well 2945 which monitors water quality beneath the inactive flyash pile, a part of Operable Unit 2. Unfiltered samples collected from Type 3 wells (approximately 50 to 60 feet beneath the water table) indicate that total uranium concentrations range up to 110 ppb (DOE 1995c, Plate E-78). The preferred approach for restoring the Great Miami Aquifer described in section 1.2 addresses uranium contamination greater than 20 ppb at all depths. At the existing pumping test well (see Figure 3-1), uranium concentrations greater than 20 ppb are limited to the upper 21 feet of the aquifer.

3.3 EXISTING GROUNDWATER EXTRACTION AND TREATMENT

Groundwater is currently being extracted, at a rate of 1400 gpm, from the Great Miami Aquifer from extraction wells located near the southern end of the South Plume as part of a removal action. These extraction wells will be combined with an additional 23 wells as part of the preferred approach to restore the aquifer. Portions of the water being pumped from the South Plume are being treated for uranium removal by the site wastewater treatment facilities before discharge to the Great Miami River. Groundwater being pumped from the South Plume flows through a 20-inch HDPE pipeline to the South Plume valve house. Here portions of the groundwater (200 to 1300 gpm) are diverted to various wastewater treatment facilities before discharge to the Great Miami River. Use of existing treatment facilities and piping to implement the preferred remedy will help minimize costs.

4.0 PROJECT WORK ACTIVITIES

This section presents details on the installation of the extraction wells and the associated testing programs. The following controls, among others, will be implemented during the installation of the wells:

- Project health and safety plan will be followed
- Physical barriers will be positioned around work areas to prevent unauthorized access
- Protective clothing and respiratory protection will be provided for workers, as required
- Administrative controls will be instituted to prevent wind erosion, dust generation, and storm water runoff control (i.e., plastic sheeting).

4.1 WELL PLACEMENT AND DESIGN

For the purpose of this initial phase of the groundwater remediation system for the South Field, eight new extraction wells will be installed on FEMP property. Each new well location will be drilled and sampled to bedrock using a rotosonic drill rig. The sampling hole will be backfilled and overdrilled using a 20-inch cable tool or air rotary rig to a depth of approximately 100 feet to provide for the installation of the recovery well. All drilling and well-completion activities will be performed in accordance with requirements contained in the Sitewide CERCLA Quality Assurance Project Plan (SCQ) (DOE 1993). Table 4-1 lists the guidelines that will be followed for well drilling, well installation, sampling, and testing.

A surveyor's stake with a highly visible ribbon tied around the top will be driven into the ground at each drilling location and location numbers will be written on each stake. The staked locations will be surveyed vertically and horizontally to the nearest 0.1 foot and approved by a State of Ohio-licensed surveyor.

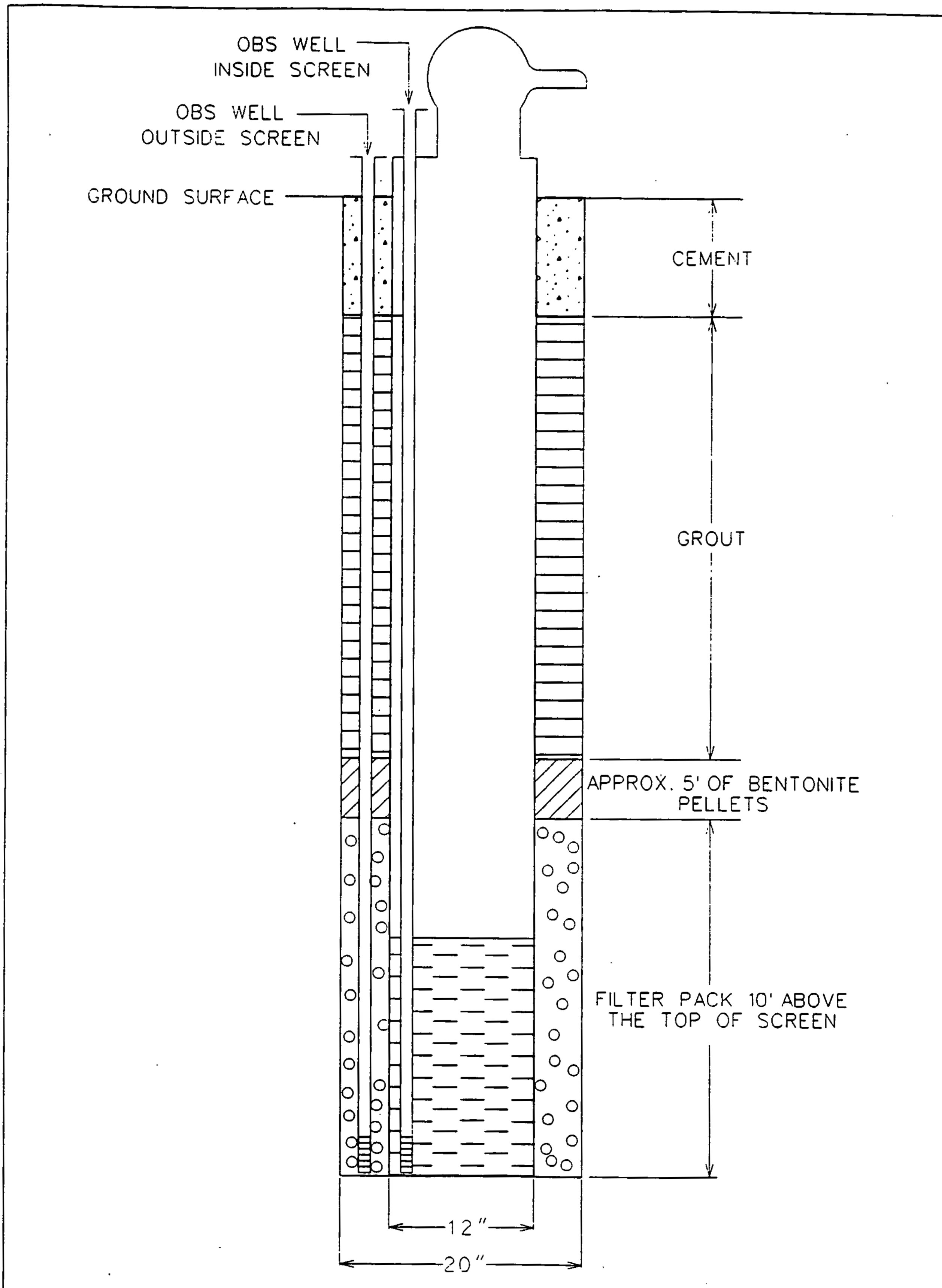
The extraction wells will be drilled and installed in two steps. The wells will first be cored and sampled to bedrock using a 6-inch rotosonic drilling tool. Groundwater and soil samples will be collected every 10 feet and submitted to the FEMP lab for total uranium and sieve analysis. The rotosonic casing will be pulled back to the water table and the formation will be allowed to collapse back into the hole. The driller will pull the casing out of the hole very slowly and verify that the hole is collapsing by taking a depth measurement every 10 to 20 feet. If blue clay is present in the hole, bentonite will be tremied into the collapsing hole, from the bottom of the hole to a depth approximately 5 feet above the top of the clay. Above the water table the hole will not readily collapse. A mixture of sand and bentonite will be tremied into the hole up to the surface to temporarily abandon the hole until cable tool or air rotary rig can be moved in to overdrill a 20-inch hole. Using a mixture of sand and bentonite, rather than pure bentonite, will cut down on some of the mess during the redrilling process. This technique was used during the drilling of Extraction Well 31550; fifteen 50-pound bags of bentonite were mixed with 300 pounds of sand and placed in the borehole from the water table to the surface. A similar ratio of sand and bentonite will be used for the wells installed under this PSP.

During step two, a 20-inch hole will be drilled to completion depth (approximately 100 feet) using a cable tool or air rotary rig (needed because a rotosonic drilling rig cannot cut a 20-inch diameter hole). The 20-inch hole will accommodate both a 12-inch internal diameter (ID) casing and a 2-inch ID PVC piezometer outside of the casing but within the boring.

The recovery wells will be constructed of 12-inch ID stainless steel. A 2-inch ID stainless steel stilling pipe will be installed inside of the screen and a 2-inch ID PVC observation well will be installed outside of the screen, but within the borehole, to assess screen efficiency. The 2-inch stilling pipe inside of the screen will have a 5-foot screen. The base of the 5-foot screen will be located at the same elevation as the base of the recovery well screen. The 2-inch PVC well located outside of the screen but within the borehole will also have a 5-foot screen, whose base will also be located at an elevation that corresponds to the base of the recovery well screen (Figure 4-1).

Table 4-1
SCQ WELL INSTALLATION GUIDELINES
(DOE 1993a)

Guidelines	Reference
<u>Administrative</u>	
Chain-of-custody	Section 7.1
Corrective action	Section 15.2
Daily logs	Section 5.1 and Appendix J, Subsection J.4.1
Variances	Section 15.4
<u>Field</u>	
General drilling practices	Section 5.2.1 and Appendix J, Subsection J.4.2
Subsurface soil sampling	Appendix K, Subsection K.5.3
Monitoring well/piezometer design, installation and abandonment	Section 5.2.2, Appendix Subsection J.4.3, EM-GW-004 *
Well development	Section 5.2.3 and Appendix J, Subsection J.4.4
Field screening of samples for radioactive contamination	Appendix K, Subsection K.5.3.2
Decontamination	Appendix K, Subsection K.11
Field storage and shipment of samples	Appendix K, Subsection K.10
Sampling of cores	Appendix K, Subsection K.5.3
Documenting cores	Appendix K, Subsection K.5.3
<u>Laboratory Tests</u>	
Grain-size analysis	ASTM D 422



5arn1/dgn/xwell.sgn

FIGURE 4-1.
EXTRACTION WELL DESIGN

000024

The extraction wells will be screened across a 20-40 foot interval, with the top of the screen located 5-8 feet below the lowest recorded seasonal water level for the area. The actual length will be determined using water quality data collected during the rotosonic drilling. The objective will be to place the screen in the portion of the plume that contains greater than 20 ppb of total uranium. The slot size and final completion method will be selected based upon sieve analysis results. It is anticipated that the wells will be completed using a filter pack and a 12-inch ID, continuous 60-slot stainless steel screen. Completion will be conducted in accordance with the SCQ (DOE 1993).

4.2 SUPPORT FEATURES AND SYSTEM SPECIFICATIONS

The uranium-contaminated groundwater will be transported to either the FEMP's wastewater treatment facilities or directly discharged to the Great Miami River. The system achieves this objective using an arrangement of pumps, pipelines, valves, and associated instrumentation. Figure 4-2 depicts a simplified line diagram of the proposed system.

The extraction wells will have vertical turbine, aboveground discharge pumps located within wellhouses. The wellhouses will be designed to protect the extraction pumps and their associated instrumentation and aboveground piping and valving. Each extraction well unit will have a sample port and the ability to divert effluent to either the well treatment header tie-in or the well discharge force main. This flow diversion will occur within the respective wellhouse using locally operated valves to isolate the discharge path.

The treatment force main is the existing 20-inch HDPE pipeline used for the South Plume Removal Action. The treatment force main will direct flow into the South Plume valve house, where it will be directed toward either the AWWT, the SPIT, or the IAWWT facilities. The new discharge main will run northeasterly from the new South Field valve house and combine with other site flows in the existing 24-inch HDPE outfall force main before discharge. Valving will be provided at this tie-in point for isolation capability.

The South Plume effluent will follow its existing flow path into the new South Field valve house where the South Plume force main will have connections with both the treatment and the discharge force mains. These connections will be valved to allow flow to be diverted into either path depending on available treatment capacity.

See Figure 4-3 for a preliminary civil site plan of the proposed system.

All new buried piping will be HDPE with fused joints; aboveground piping will be carbon steel with welded joints and flanged connections either heat traced or located within valve or wellhouses. The

ILLUS\OU-5\PO-126\WELL HOUSE.EPS

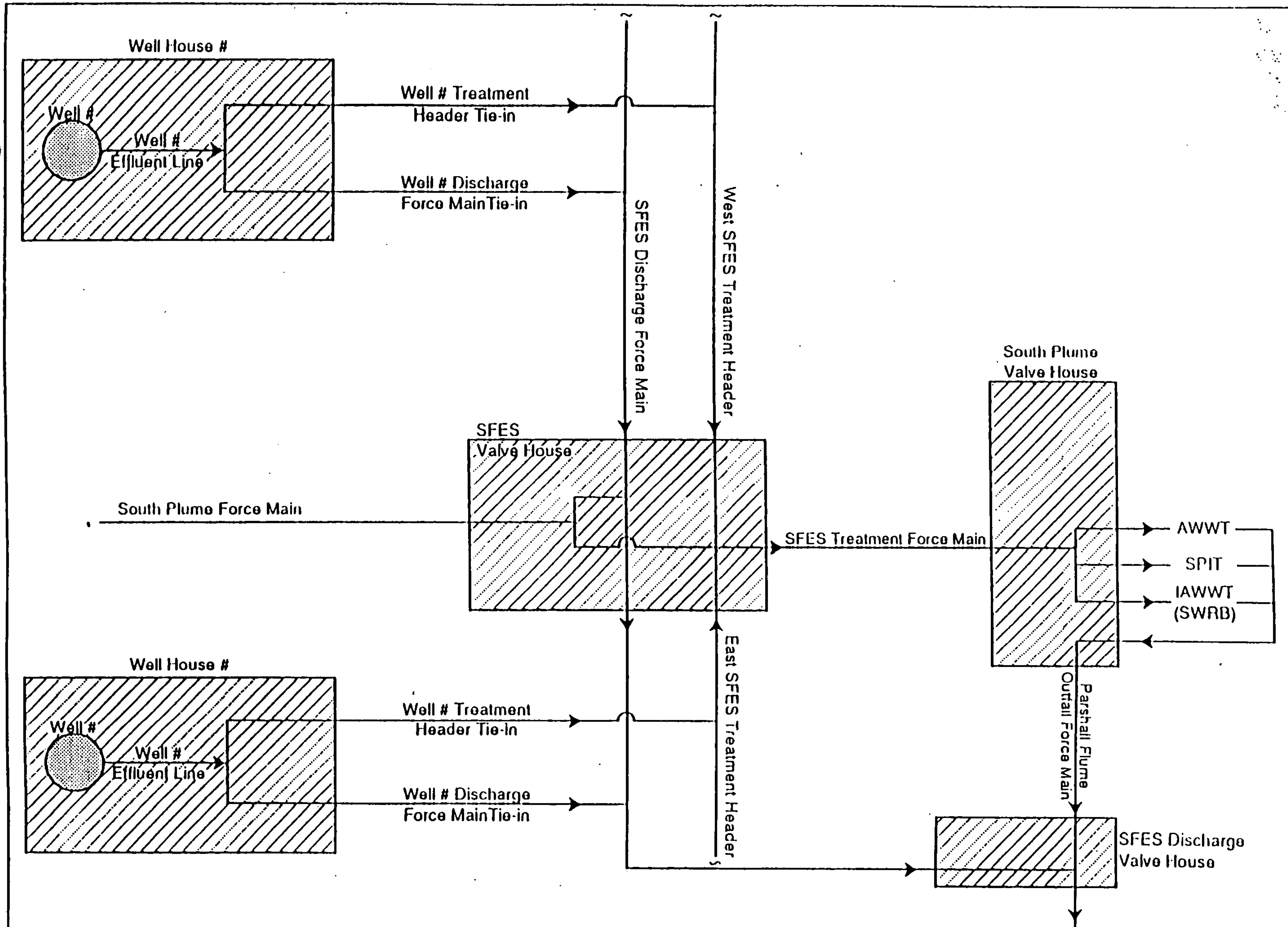
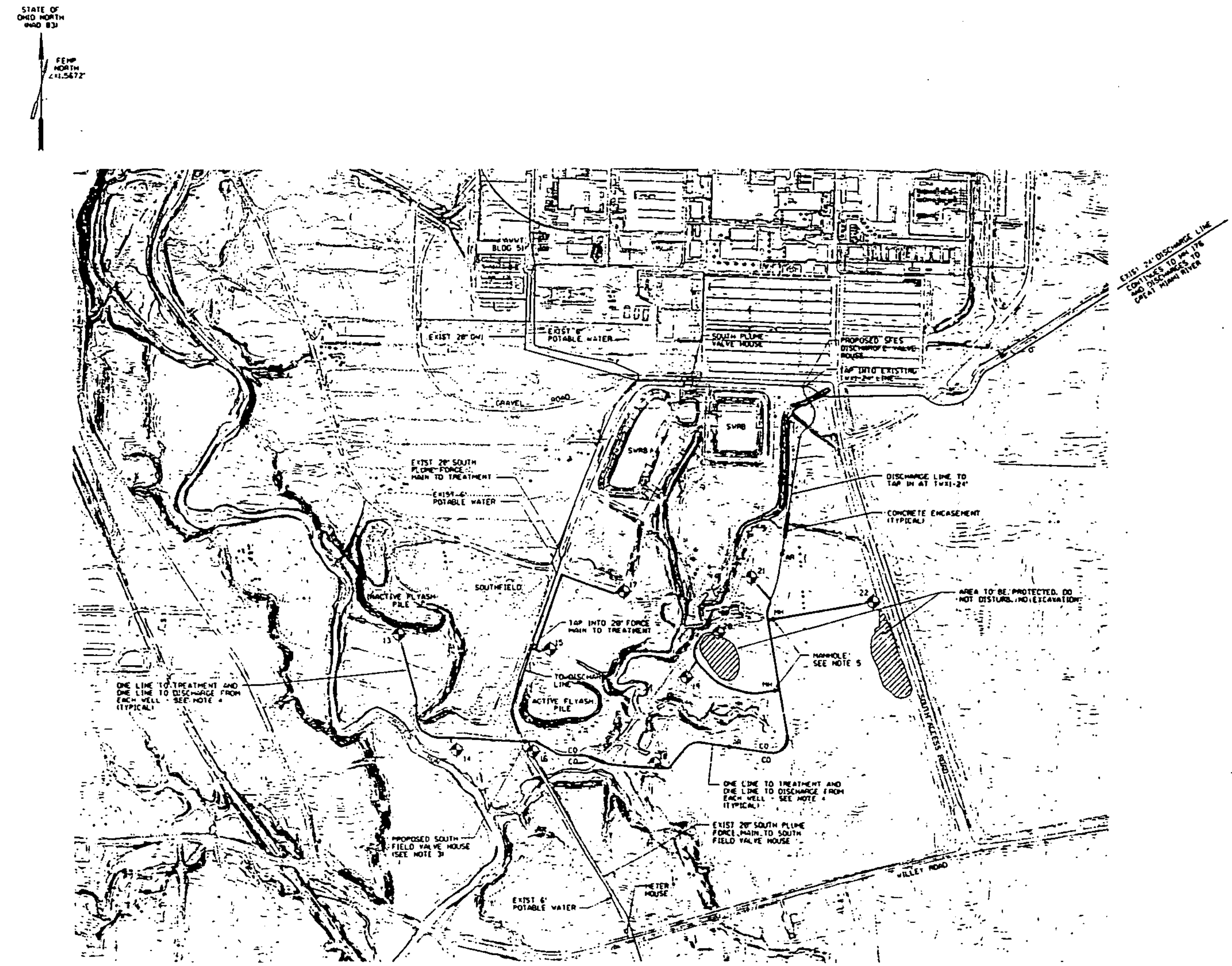


FIGURE 4-2. SIMPLIFIED LINE DIAGRAM OF THE PROPOSED SYSTEM



NOTE: WELL NO. 22 AND PIPELINE ARE CONTINGENT.

NOTES

1. EXISTING CONDITIONS SHOWN ON THIS DRAWING WERE PREPARED FROM FEMP SITE PROVIDED DATA FROM DOCUMENTS LISTED BELOW:

PARSONS TOPOGRAPHY, 1992
FEMP CADD GRID/UTILITY DRAWINGS
FEMP CONTRACTOR PROJECT DESIGN DOCUMENTS

2. ACTUAL LOCATION OF THE WELL HOUSE WILL BE CLOSER TO THE WELL HEAD THAN SHOWN.

3. GROUNDWATER WILL BE SENT TO TREATMENT BY THE EXISTING SOUTH PLUME LINE, GWI-20"-01. THE EXISTING 20" LINE SOUTH OF THE PROPOSED SOUTH FIELD VALVE HOUSE WILL BE DIVERTED TO EITHER DISCHARGE OR TREATMENT IN VALVE HOUSE.

4. SIZES OF PIPELINES WILL RANGE FROM 4" TO 20" DIAMETER. MATERIAL WILL BE HDPE. FINAL PIPE SIZES, CLEAN OUT, MANHOLES AND VALVE LOCATIONS WILL BE DETERMINED IN TITLE II DESIGN.

5. MANHOLES COULD CONTAIN CLEANOUT PORTS, ISOLATION VALVES, AND CHECK VALVES. ARRANGEMENT OF EACH MANHOLE WILL BE DETERMINED IN TITLE II DESIGN.

LEGEND

EXISTING		PROPOSED
	AIR RELEASE CHAMBER	AR
	BUILDING	
	CLEANOUT MANHOLE	CO
	EXTRACTION AND WELL HOUSE	
	MAJOR CONTOUR	
	MINOR CONTOUR	
	MANHOLE	MH
	PIPELINE	
	SITE BOUNDARY	

PRELIMINARY
NOT FOR CONSTRUCTION

0 ISSUED FOR FR & DBD

UNITED STATES
DEPARTMENT OF ENERGY
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

PARSONS
THE RALPH M. PARSONS CO. - PARSONS MAIN, INC. - ENGINEERING-SCIENCE, INC.
CINCINNATI, OHIO

GROUNDWATER REMEDIATION
TITLE I/II DESIGN

CIVIL
SITE PLAN
SOUTH FIELD EXTRACTION SYSTEM

R. ESPARZA
1"=200'

CRU5/P0128
WBS 1.1.1.5.3 00-90701 95X-5900-G-00192 G0001 0

FIGURE 4-3. SITE PLAN OF THE PROPOSED SYSTEM

2054
124

000027

South Field extraction well system will be remotely monitored at the AWWT control room for flow and pump discharge pressure at each well and wellfield header operating pressures, but flow and pump discharge will be controlled at the valve houses. Pumps will be the vertical turbine type. Flow rates will vary between 100 to 450 gpm depending on the location of the well. Pumping will be sequenced throughout the life of the project as outlined in the Operable Unit 5 FS (DOE 1995a, Section F.7).

4.3 SAMPLING, SAMPLE HANDLING AND SHIPPING

A rotosonic drilling method was chosen for sample collection because it efficiently provides a continuous sample or core. Such a sample is necessary to detect and document depositional features such as cross bedding, fining up and down sequences, etc. An understanding of the depositional features will aid in optimizing the cleanup of the Great Miami Aquifer. A sample matrix and sampling instructions are provided in Attachments B and C, respectively. All sampling will be conducted in accordance with guidelines presented in the SCQ, Appendix K.

The sampling program will consist of the following:

- A continuous rotosonic core will be collected from each boring to bedrock.

- The rotosonic core will be described in the field by a geologist (Munsell color, USCS soil classification, textural description, and depositional features) before any extraction of samples. A lithologic log will be completed that will also record depositional features such as cross bedding. The entire core will be photographed.

- Groundwater samples will be collected (pumped) from each boring every 10 feet during drilling, beginning at the water table. The groundwater samples will be submitted to the FEMP lab for total uranium analysis (analytical support level [ASL] B). The groundwater sampling device will consist of a friction packer and wellpoint. Concentration data measured from the groundwater samples will be used to construct a uranium contamination profile of the drilling area. The groundwater total uranium concentrations will be matched against soil uranium concentrations to estimate a soil-to-water total uranium partitioning coefficient (K_d).

- Soil samples will be extracted from the rotosonic core every 10 feet (beginning at the water table) to correspond to the depth of the groundwater sampling. The soil samples will be tested for total uranium at the FEMP lab (ASL B). Total uranium concentrations in soil will be matched against total uranium concentrations in the groundwater to estimate a total uranium K_d.

- Desorption batch tests will be conducted using soil samples collected from areas of the plume where groundwater uranium concentrations are greater than 20 ppb. Groundwater from the Great Miami Aquifer which is not contaminated with uranium will be used during the batch tests as the leaching agent. The batch test procedure that will be used is consistent with the procedure used during the EPA-approved Operable Unit 5 K_d soil sampling and analysis project. The desorption batch tests will be conducted for a minimum of 16 days and results will be used to further refine in situ K_d estimates made by matching uranium concentrations in groundwater to soil as described above.

- Soil samples will be extracted from the rotosonic core (every 10 feet outside of the proposed screened depth) beginning at the top of the Great Miami Aquifer and submitted to the FEMP lab for sieve analysis (ASTM D 422, ASL B). Results of the sieve analysis will be used to make grain-size determinations and USCS soil classifications.

- Soil samples will be extracted from the core (every 5 feet) across the proposed screen interval and submitted to the FEMP lab for sieve analysis (ASTM D 422, ASL B). Results will be used to make grain-size determinations and USCS soil classifications. Results will aid in the selection of a final screen size and completion method.

- The remaining core will be saved in core boxes and archived for future use.

The installation of the extraction wells will disturb soil in the uncontrolled area of the site, most of which had been used for cattle grazing. Portions of the area have previously been sampled (i.e., South Plume Force Main and Advanced Wastewater Treatment Project) and the soil was determined to be nonhazardous under the Resource Conservation and Recovery Act and below proposed cleanup levels.

The management of waste (if any) from this project will be controlled by Site Standard Operating Procedure (SSOP)-0044, Management of Soils, Debris, and Waste from a Project, and Removal Action 17, Improved Storage of Soil and Debris. All waste (if any) generated from this project will be monitored for radioactivity before final disposition.

Immediately following collection of a sample, a sampling technician will survey each sample with a Geiger Muller frisker and an alpha meter and the readings recorded and reported to the Lead Geologist. Immediately following containerization, each sample will be labeled and sealed with custody tape; boxes containing archived core will not be custody taped. A unique sample number will be assigned to each collected sample being submitted to the FEMP lab and samples will be logged and scheduled into the site Fernald analytical computerized tracking system. Each sample submitted to the FEMP lab will be affixed with a label containing, at a minimum, the unique sample number, WBS number, location number, sample matrix, depth interval sampled, collection time, sampler's initials, geotechnical or analytical parameters, and field screening results. The custody tape will be initialed and dated by the sampler.

Sample custody procedures outlined in the SCQ will be adhered to throughout the sample handling process from field collection to shipment of the samples to the laboratory. An analysis request/custody record will be used to document collection of data, chain-of-custody and geotechnical parameters requested for each sample.

In addition to the custody records, a sample collection log will be completed which summarizes all samples collected from a single borehole. All field work will be documented in detail daily using the field activity log. All field documentation will be completed by the Lead Geologist.

Sample custody seals will be examined and verified by FEMP sample processing laboratory personnel before acceptance of the samples. The field screening results will be clearly displayed on the sample label and the analysis request/custody record. Sample packaging will be in accordance with the SCQ, Section K.10. Final sample handling, screening, storage, and shipping activities will be completed by the FEMP sample processing laboratory.

All equipment used during this investigation will be operated and calibrated according to the manufacturer's specifications. Written logs of equipment calibration are maintained by the FEMP personnel responsible for performing the instrument calibrations.

Excess groundwater generated during the sampling process will be sent to a collection tank at the drill investigation site. Water will be trucked to the storm water retention basin and disposed of in a manner consistent with the site aqueous investigation-derived waste (IDW) policy. Cuttings generated during the drilling operation will be handled in accordance with procedures outlined in Removal Action 17.

Drill cuttings generated during the installation of the extraction wells will be deposited on the ground surface near the respective drilling locations and managed in accordance with the Operable Unit 5 interim IDW policy (for drill cuttings). Subsurface analytical data collected from rotosonic cores at locations where the extraction wells will be installed provide the basis for the comparative determination between boring and ground surface contaminant concentrations. Soil with concentrations of uranium greater than surface concentrations will be drummed consistent with the IDW policy.

4.4 WELL DEVELOPMENT

Surging techniques (surge blocks) and pumping will be used to develop the wells. Fines will be removed from the borehole as often as possible (Driscoll 1986). Development will continue until the turbidity of the water is clear, the nephelometric turbidity unit (NTU) reading has stabilized to five NTUs or less, and pH, specific conductance, temperature, and dissolved oxygen readings have stabilized. This development method is subject to change pending results of the sieve analysis. If a large amount of fines are present in the area, an alternate development method may be preferred. Surging techniques are recommended in the FEMP SCQ for high-yield aquifers such as the Great Miami Aquifer. Field readings and data will be documented by site restoration services technicians.

A temporary line will be constructed to transmit development water to either the South Plume force main or the storm water retention basin depending upon the location of the well being developed. Given the size of these wells, development could take up to three days and includes both surging and pumping. Approximately 324,000 gallons of groundwater will be pumped at each well during development (600 gpm, 3 hours per day, 3 days). The actual mass of uranium removed at each well during development will vary depending upon the concentration of uranium present at each particular well.

Groundwater quality data collected for the RI indicates that the recovery wells will be located in areas of the Great Miami Aquifer that have total uranium concentrations ranging up to approximately 950 ppb. Well 31550 is the existing pumping test well being converted to an extraction well for the South Field extraction system. During pumping of Well 31550, the total uranium concentration of the pumped groundwater, as measured at the well head, was only measured 71 percent of the average groundwater concentration measured just below the water table of the aquifer. A similar relationship is anticipated for development of the other extraction wells. During development the maximum total uranium concentration of the pumped groundwater, as measured at the wellhead, is estimated to be 675 ppb. Calculations indicate that during development, pumping groundwater with a total uranium concentration of 675 ppb will result in a discharge of 30.8 ppb total uranium to the Great Miami River. The concentration of total uranium discharged to the river was determined by mixing the pumped groundwater from the well being developed with the discharge water being pumped from the South Plume recovery wells and treating 30 percent of the total flow down to 5 ppb before releasing it to the Great Miami River. Calculations are provided in Attachment D. The mass of total uranium discharged to the river will be approximately 2 pounds of uranium. Because 675 ppb represents what should be the highest concentration of total uranium to be pumped during development of the recovery wells, the total uranium concentration discharged to the Great Miami River during the development of the other extraction wells should be less than 30.8 ppb. If all eight wells have a pumped total uranium concentration of 675 ppb during development, approximately 16 pounds of uranium will be released to the river.

Water quality data collected during the drilling process will be used to calculate an estimated mass of uranium removed during development. The mass calculations will be used to plan wastewater treatment such that uranium concentrations in the wastewater discharged to the Great Miami River are as low as can be achieved. Water samples will be collected from the pumped water during the development process. These samples will be submitted to the FEMP lab for total uranium analysis (ASL B) so that the actual concentration can be recorded.

4.5 PERFORMANCE MONITORING

The effectiveness of the recovery wells in achieving remediation goals will be monitored and evaluated throughout the life of the extraction system. Specifics concerning the monitoring will be addressed in the O&M plan to be submitted as a followup to this PSP and, from a global basis, in the Remedial Design documents submitted in accordance with the Operable Unit 5 Remedial Design Work plan. It is anticipated that monitoring the effectiveness of the recovery wells will include such items as:

- Monitoring the shape and volume of the 20 ppb total uranium plume to document how effective the remediation strategy is in not enlarging the plume.
- Monitoring to document whether or not total uranium concentrations greater than 20 ppb are avoiding capture by slipping around or beneath extraction wells.
- Monitoring for total uranium in pumped groundwater at individual wellheads to document how close the total uranium concentrations in the actual pumped groundwater are to predicted concentrations, and to decide whether or not the pumped water needs to be routed to a treatment system.
- Monitoring the specific capacity of each well to determine if efficiency is decreasing over time.
- Monitoring the shape and extent of the net radius of influence to determine how close the overall hydraulic impact to the Great Miami Aquifer is to modeled predictions.

4.6 CULTURAL RESOURCES

A cultural resource and archaeological survey will be completed at each drilling location and along the path of the proposed pipelines to determine the presence of any historic properties within the area of potential effect. If it is determined that historic properties are present and will be effected, appropriate avoidance and/or mitigation steps will be undertaken.

5.0 DECISION POINTS AND CONTINGENCIES

A small degree of flexibility needs to be maintained to address new information learned through the drilling and installation of the wells. As data is collected during well drilling and well completion (soil samples and sieve analysis data), decision points will be reached where contingencies may need to be considered. These decision points and possible contingencies are outlined below:

1) Interpretation of rotosonic cores collected from the wells can be used to assess how effectively the design deals with vertical textural variability caused by depositional features (e.g., cross bedding, fining up or down sequences, etc.).

   Just as horizontal hydraulic conductivity varies spatially in a horizontal plane (see Section 3.1), the distribution of hydraulic conductivity can also change with depth. This is expected in a braided stream deposit. Textural pathways can create preferential flow pathways that have relatively higher hydraulic conductivities than the surrounding sand and gravel. Contaminants move through the pathways of least resistance. The proposed position or length of some or all of the screens may need to be altered to address actual subsurface textural features.

2) Vertical profiles of uranium contamination, made from measurements taken of groundwater samples collected during drilling of the rotosonic core, will be used to adjust the proposed depth and length of the extraction well screen.

6.0 DATA MANAGEMENT AND ANALYSIS

Data collected during the investigation will be managed during and following the field activities to ensure accurate records are maintained. Data and field documentation generated during the investigation will be checked to ensure compliance with the data quality objectives for the project.

As specified in Section 5.1 of the SCQ, sampling teams will describe daily activities on the field activity log so the sampling team can reconstruct significant activities that occurred during the work day without reliance on memory. The lead geologist will complete lithologic logs for each boring as specified in Section J.4.1.2 of the SCQ and sample collection logs will be completed according to instructions specified in Appendix B.

To ensure the appropriate documentation was completed during field activities, field documentation will be checked for completeness and accuracy.

Total uranium data for sediment and groundwater samples, measured in the FEMP lab, will be entered into the FEMP site-wide environmental database. Manual, double keyed data entry will be performed and the entered data will be compared to the original data sheets; corrections will be initialed and dated, and made as necessary. Hard-copy documents are kept in permanent storage in the project files, filed under WBS 50.05.32, and the electronic database is archived in a neutral ASCII file format.

As-built drawings will be completed following project construction activities. Current and up-to-date system as-built drawings will be maintained for the operational life of the system.

7.0 HEALTH AND SAFETY

A project-specific health and safety plan will be developed to support all field activities including well installations and development, and the installation and startup of the piping and supporting systems.

8.0 QUALITY ASSURANCE/QUALITY CONTROL

All work will be conducted in accordance with the requirements of the overall quality assurance program at the FEMP. Drilling, sampling, well installation, pumping test activities, and laboratory testing will be assigned the proper quality level. The "Quality Assurance Program Plan" provides guidelines for matching quality program requirements to quality levels. Specific quality items will be reviewed by FERMCO staff to verify that the quality requirements are adequate and consistent with the assigned quality level. Field quality control will be consistent with guidance provided in the SCQ (DOE 1993).

9.0 REFERENCES

Driscoll, F. G., 1986, Groundwater and Wells, 2nd Edition, Johnsons Division, St. Paul, MN.

U.S. Department of Energy, 1993, "Sitewide CERCLA Quality Assurance Project Plan," Fernald Environmental Management Project, DOE, Fernald Field Office, Cincinnati, OH.

U.S. Department of Energy, 1995a, "Feasibility Study Report for Operable Unit 5," Fernald Environmental Management Project, DOE, Fernald Area Office, Cincinnati, OH.

U.S. Department of Energy, 1995b, "Project-Specific Plan for Operable Unit 5 K_1 Soil Sampling Analysis," Fernald Environmental Management Project, DOE, Fernald Area Office, Cincinnati, OH.

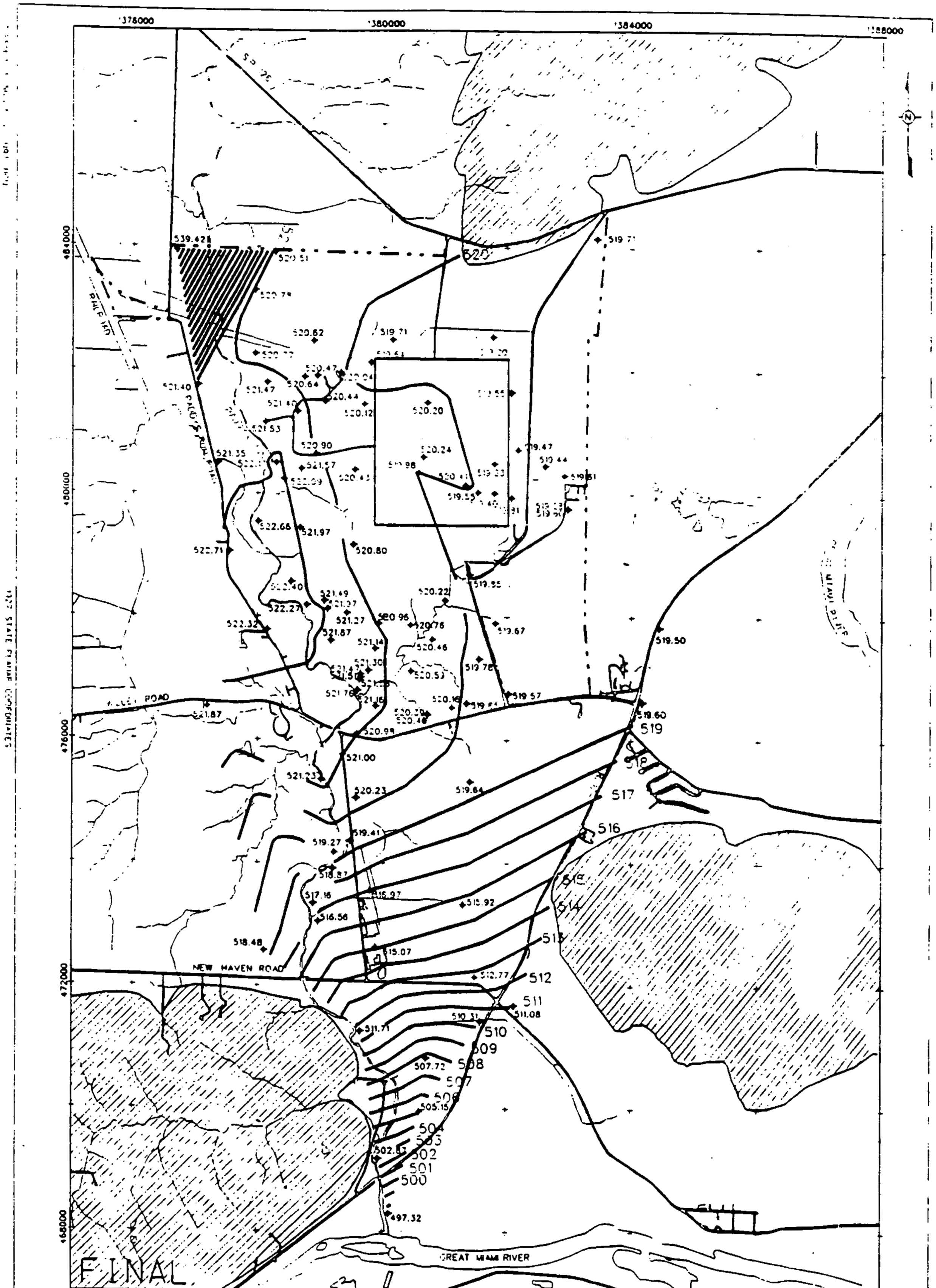
U.S. Department of Energy, 1995c, "Proposed Plan for Operable Unit 5," Final, Fernald Environmental Management Project, DOE, Fernald Area Office, Cincinnati, OH.

U.S. Department of Energy, 1995d, "Remedial Investigation Report for Operable Unit 5," Fernald Environmental Management Project, DOE, Fernald Area Office, Cincinnati, OH.

U.S. Environmental Protection Agency, 1992, "General Methods for Remedial Operation Performance Evaluations," EPA/600/R-92/002, Kerr Env. Research Lab, Ada, OK.

ATTACHMENT A

WATER LEVEL DATA



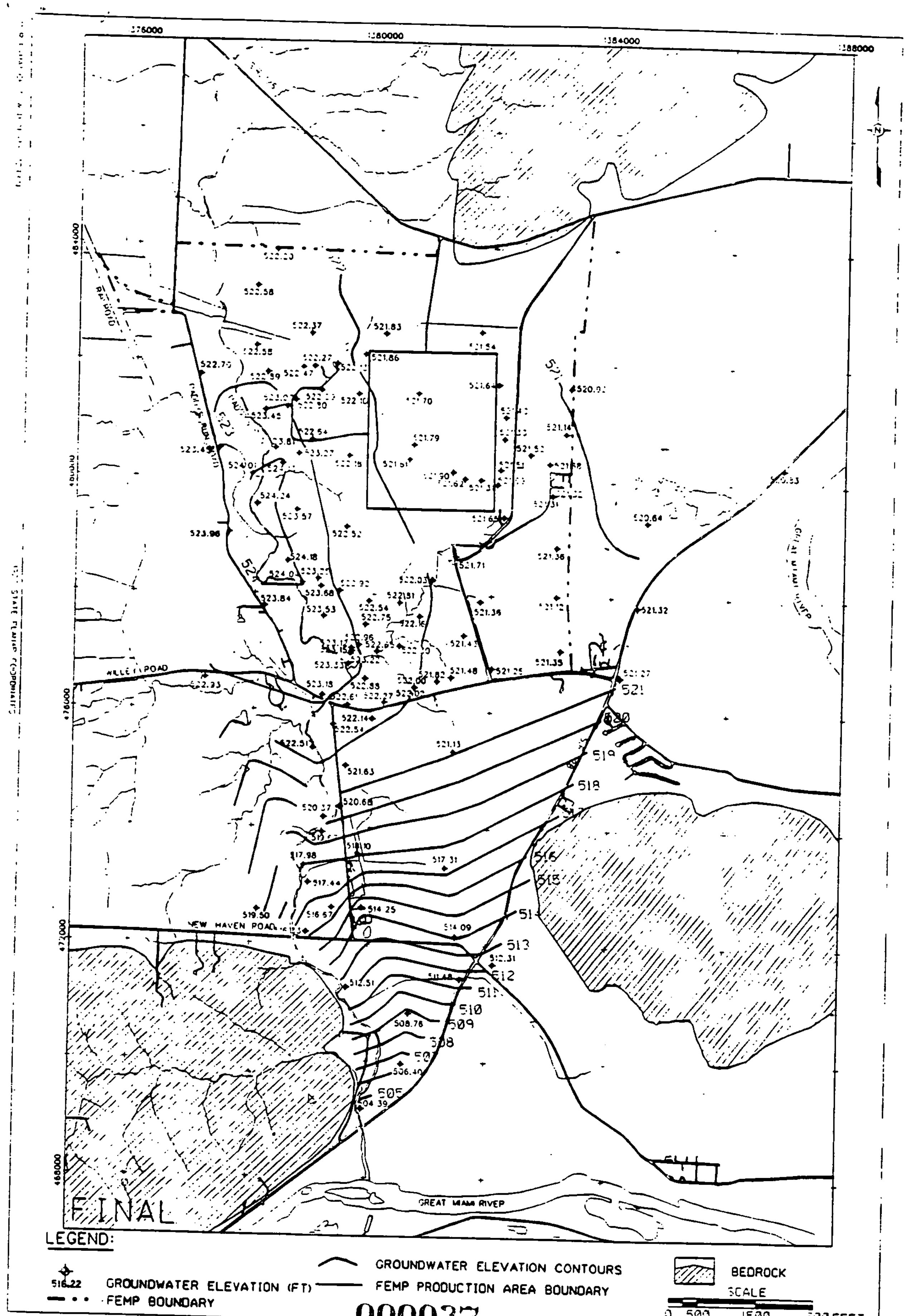
LEGEND:

- 516.22 GROUNDWATER ELEVATION (FT)
- FEMP BOUNDARY
- GROUNDWATER ELEVATION CONTOURS
- FEMP PRODUCTION AREA BOUNDARY
- BEDROCK

SCALE
0 500 1500 2500 FEET

000036

FIGURE A-1. GROUNDWATER ELEVATIONS, TYPE 2 WELLS, JANUARY 1993



000037

FIGURE A-2. GROUNDWATER ELEVATIONS, TYPE 2 WELLS, APRIL 1993

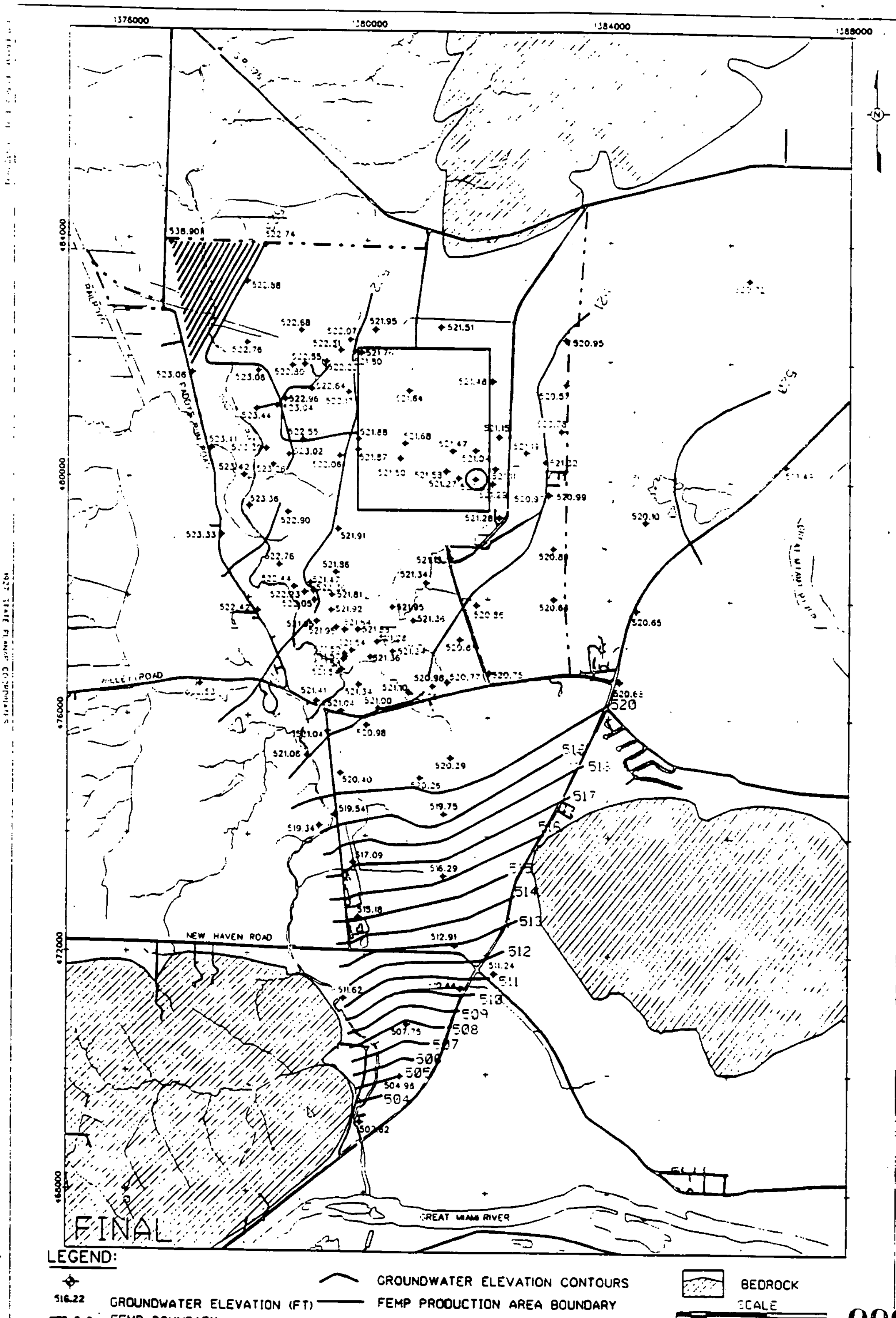
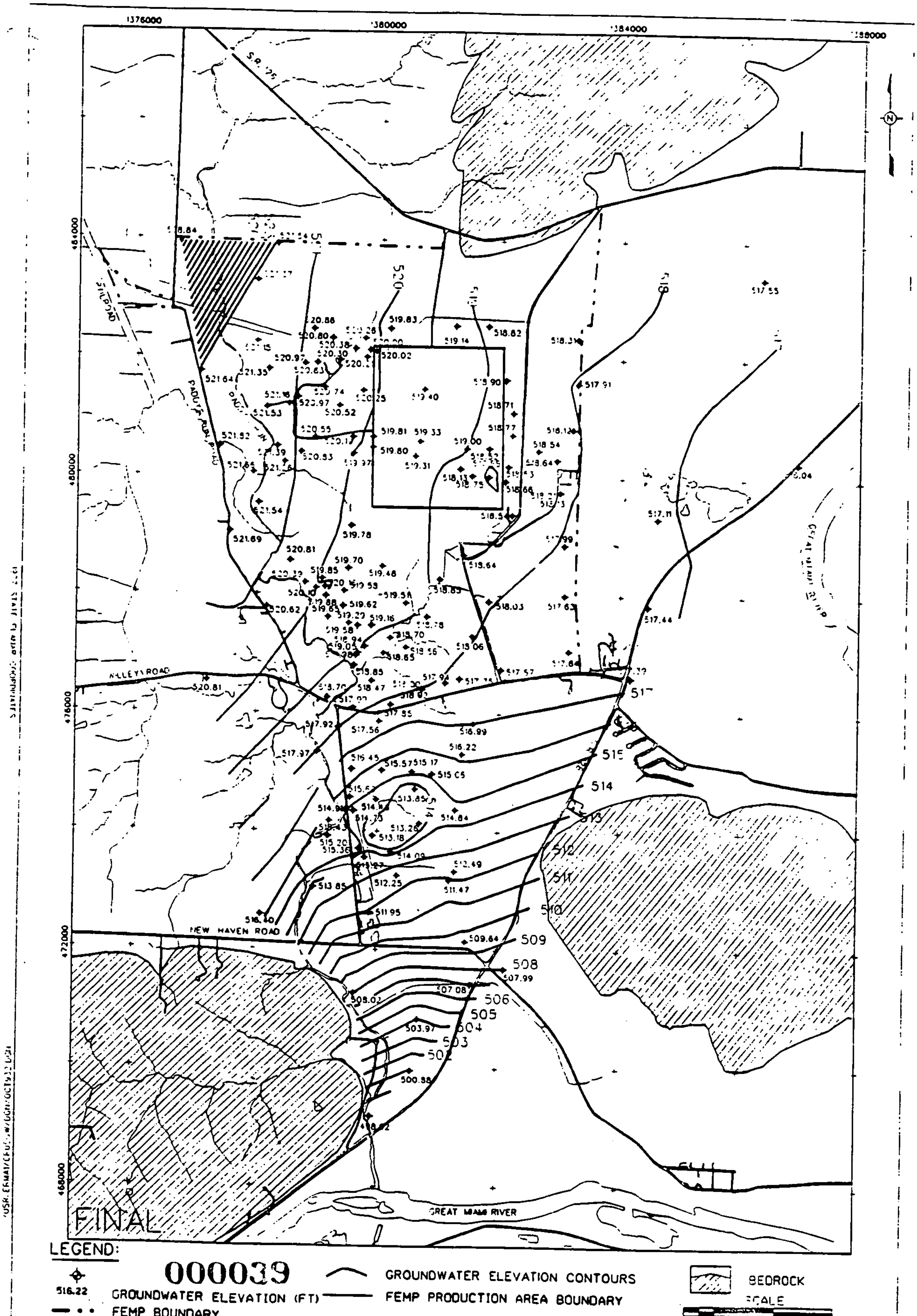


FIGURE A-3. GROUNDWATER ELEVATIONS, TYPE 2 WELLS, JULY 1993



000039

FIGURE A-4. GROUNDWATER ELEVATIONS, TYPE 2 WELLS, OCTOBER 1993

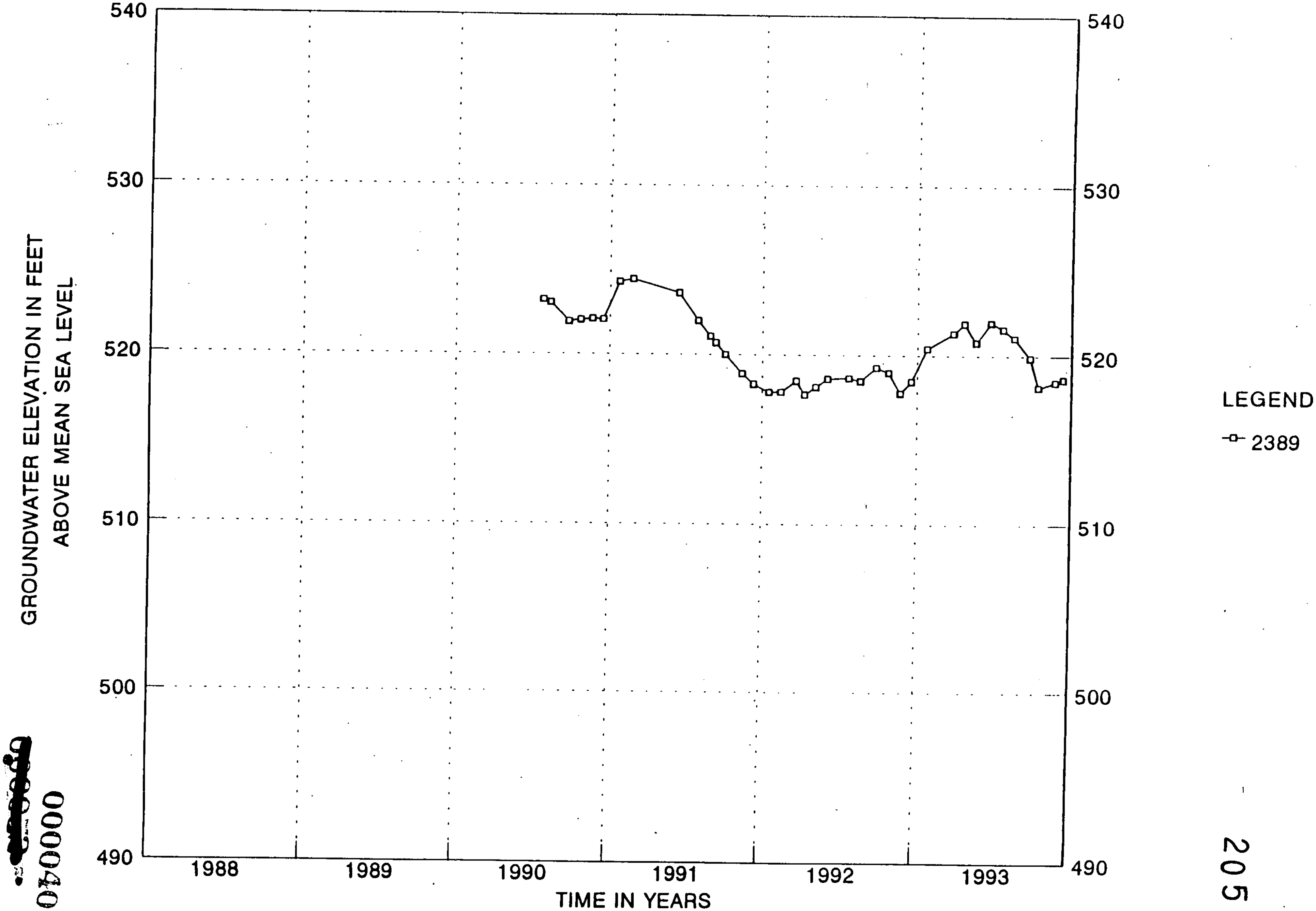


FIGURE A-5. HYDROGRAPH FOR WELL 2389

000040

2054

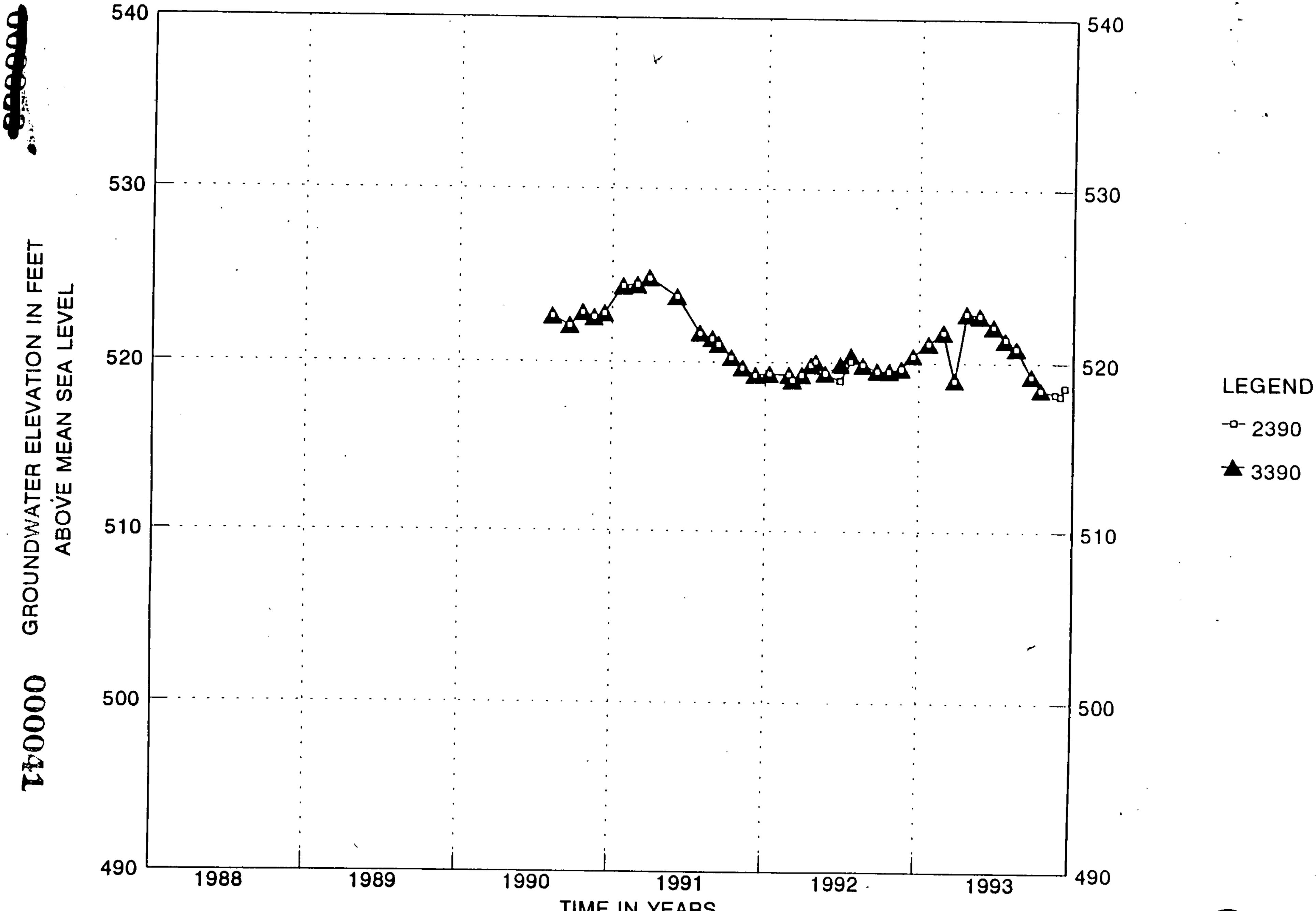


FIGURE A-6. HYDROGRAPH FOR [illegible] CLUSTER 390

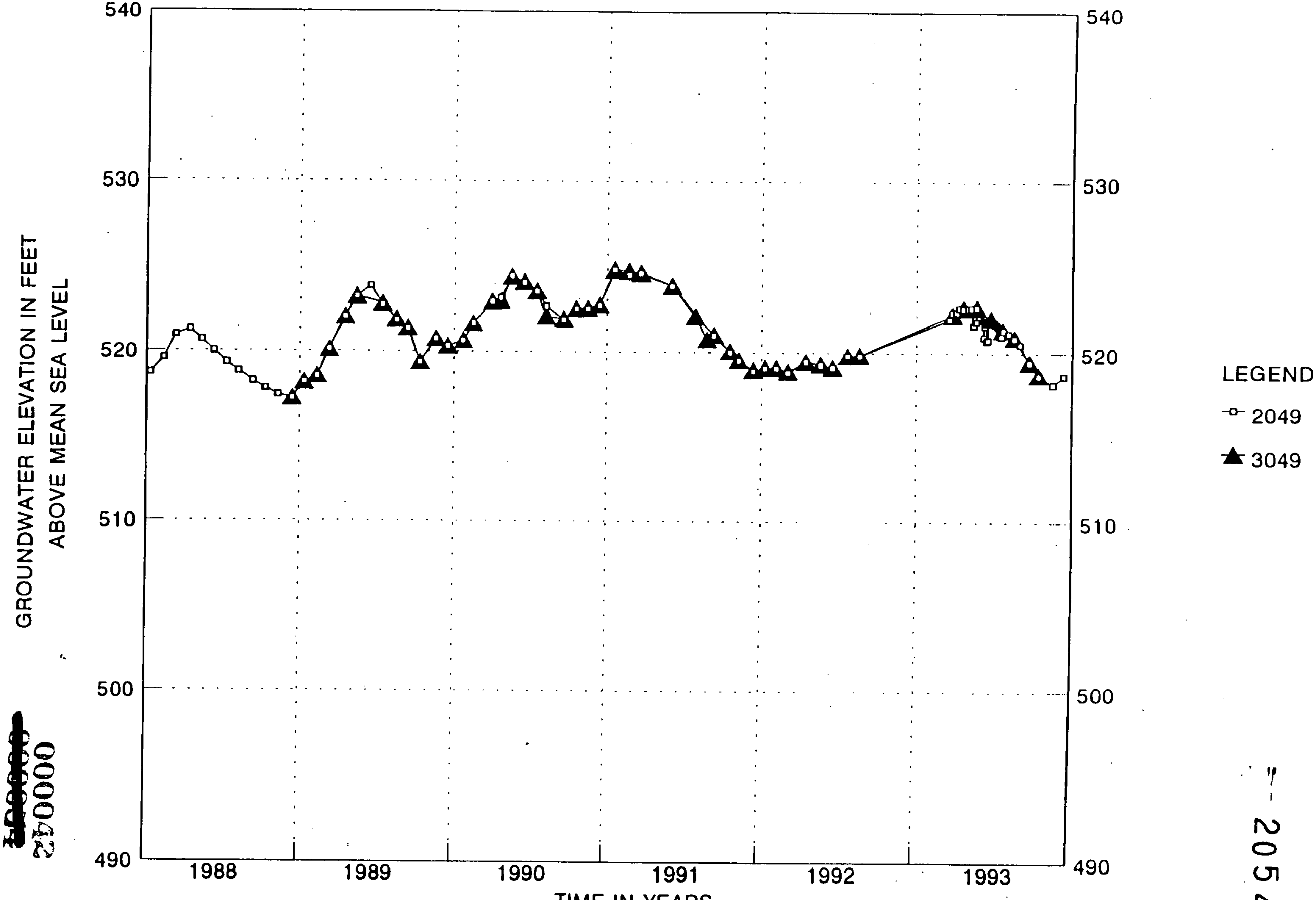


FIGURE A-7. HYDROGRAPH FOR WELL CLUSTER 049

2054

ATTACHMENT B

SAMPLING MATRIX

CRUS\PSPMCMSOUTH.PSP\August10, 1995 4:38pm

ATTACHMENT B

South Field Extraction System Sampling Matrix					
Analyte	No. of Samples	Frequency	Matrix	Lab/Field	Turnaround Time
Uranium-total	85 77 samples 4 duplicates 4 field blanks	Every 10 ft	Groundwater	Lab (on site)	1 week
Uranium-total	85 77 samples 4 duplicates 4 field blanks	Every 10 ft	Soil	Lab (on site)	1 week
Uranium-total K_d desorption batch test	Approximately 40 samples	Every 5 ft in selected intervals of plume	Groundwater /soil	Lab (on site)	16 days
Sieve analysis for grain size	106	Every 10 ft	Soil	Lab (on site)	ASAP
Sieve analysis for screen size selection	14	Every 5 ft	Soil	Lab (on site)	ASAP
Turbidity pH Specific conductance Temperature Dissolve oxygen	Indeterminate	Until turbidity = < 5 NTU	Groundwater	Field	N/A

~~000036~~ 000044

2054

ATTACHMENT C

SAMPLING INSTRUCTIONS

ATTACHMENT C

SAMPLING INSTRUCTIONS FOR THE EIGHT WELLS IN THE SOUTH FIELD EXTRACTION SYSTEM

<u>DRILLING GUIDELINES</u>

Collecting Samples:

- Groundwater and soil samples will be collected beginning at the water table and every 10 feet thereafter to the total depth of the borehole.
- Sieve samples will be collected every 10 feet, starting at the top of the Great Miami Aquifer, excluding the proposed screened interval. Sieve samples will be collected every 5 feet starting at the top and down through the entire proposed screened interval.

<u>CORE WORK</u>

- Screen core for volatiles after extraction from the rotosonic casing
- Move core into trailer <u>or</u> temporarily store it under the trailer
- Cut open the core sleeve
- Screen the core for radionuclides using the pancake frisker
- Photograph the core
- Describe the lithology/depositional features; record on the soil classification log
- Archive core per site procedures.

ATTACHMENT D

CALCULATION OF THE CONCENTRATION OF TOTAL URANIUM DISCHARGED TO THE GREAT MIAMI RIVER DUE TO WELL DEVELOPMENT

ATTACHMENT D

Calculation of the concentration of total uranium released to the Great Miami River due to the development of a recovery well with a total uranium concentration of 675 ppb in the pumped groundwater is as follows. The groundwater pumped from the well during development is mixed with groundwater being pumped from the South Plume recovery wells. Thirty percent of the combined flow is treated to an assumed concentration of 5 ppb before being released to the Great Miami River.

Input to calculations:

- Development will take 3 days or 72 hours
- During development the well will be pumped at 600 gpm for 3 hours a day for 3 days or 9 hours (540 minutes) total.
- Groundwater pumped from the South Plume recovery wells will move through the force main at a rate of 1400 gpm and a concentration of 18 ppb.
- During 72 hours an additional 1.642×10^6 gallons of water from other flow streams will be treated to an assumed concentration of 5 ppb of total uranium and be available for mixing into the flow stream being discharged to the Great Miami River.

South Plume Recovery Wells
1400 gpm @ 18 ppb for 72 hours

Development of Well
600 gpm @ 675 ppb for 9 hours

↓

Combined Volume[a]
6.372×10^6 gallons @ 51.41 ppb

↓ ↓

70% untreated
4.460×10^6 gallons
@ 51.41 ppb

30% treated to
1.912×10^6 gallons
@ 5 ppb

Other treated flow
1.642×10^6 gallons
@ 5 ppb

↓

30.8 ppb total uranium released to Great Miami River[b]

[a]Combined volume and concentration before treatment

$$\frac{[(6.048x10^6\ gal)(18\ ppb)]+[(3.24x10^5\ gal)(675\ ppb)]}{6.372x10^6\ gal} = \frac{(1.089x10^8\ gal\ x\ ppb)+(2.187x10^8\ gal\ x\ ppb)}{6.372x10^6\ gal} = 51.41\ ppb$$

[b]30% (6.372×10^6 gallons) = 1.912×10^6 gallons
70% (6.372×10^6 gallons) = 4.460×10^6 gallons

Total volume at 5 ppb concentration = 1.912×10^6 gallons + 1.642×10^6 gallons = 3.554×10^6 gallons

$$\frac{[(3.554x10^6\ gal)(5\ ppb)]+[(4.460x10^6\ gal)(51.41\ ppb)]}{8.014x10^6 gal} = \frac{(1.777x10^7\ gal\ x\ ppb)+(2.293x10^8\ gal\ x\ ppb)}{8.014x10^6\ gal} = 30.8\ ppb$$

ATTACHMENT E

BACKGROUND ON THE SELECTION OF EXTRACTION WELL LOCATIONS IN THE SOUTH FIELD EXTRACTION SYSTEM

BACKGROUND ON THE SELECTION OF EXTRACTION WELL LOCATIONS IN THE SOUTH FIELD EXTRACTION SYSTEM

Executive Summary

Individual wells within the South Field Extraction System are located within a uranium plume in the Great Miami Aquifer, whose extent and location has been defined in the Operable Unit 5 Remedial Investigation (RI) Report (DOE 1995b, Section 4.0). Figure 1 shows the location of the South Field extraction wells in relation to the 20 μg/L total uranium plume which was also defined in the Operable Unit 5 RI Report (see Plate E-77) using unfiltered groundwater samples collected in 1993. Figure 2 shows the location of the South Field extraction wells in relation to the 20 μg/L total uranium plume which was used in groundwater modeling exercises for the Operable Unit 5 Feasibility Study (FS) Report. The plume defined for the FS modeling was constructed from five different data sources and is conservatively biased to depict maximum total uranium plume concentrations (DOE 1995a, Appendix F, Section F.7.2.4). The wells are strategically located to extract the most uranium possible in the shortest period of time using the most efficient number of wells and considering the conservative plume configuration. The location and number of extraction wells proposed for the remediation of the uranium plume in this area were determined by conducting over 16 different modeling exercises for the Operable Unit 5 FS Report (DOE 1995a, Appendix F, Sections 7 and 8), followed by 10 modeling exercises to evaluate the supplemental use of reinjection. Knowledge of the area (i.e., planned soil remediation activities and physical terrain) was also factored into the well-location selection process. Aquifer testing conducted after completion of the FS Report shows that:

- The model is calibrated properly for hydraulic conductivity within this area of the plume
- The plume is located where it was predicted to be in the RI Report
- Partition coefficients for uranium are within the range of values used for the FS modeling.

Subsequent to completion of the FS Report, numerous modeling simulations were conducted to explore the reinjection option. These simulations were developed into 10 different modeling exercises. The extraction well locations were further adjusted to better accommodate possible reinjection patterns and to maximize extraction efficiency within the patterns. An overview of these modeling efforts was presented to the U.S. Environmental Protection Agency (EPA) and Ohio EPA (OEPA) at a meeting in Chicago on May 3, 1995.

Common to the proposed remediation strategy for the Great Miami Aquifer (extraction alone) and the ongoing reinjection evaluations is that the location of the extraction wells will not change. The results of over 26 modeling exercises indicate that the wells are located in the most optimal extraction locations for the area and that they facilitate the supplemental use of reinjection.

Background Information

The South Field Extraction System is one of four extraction systems proposed in the Operable Unit 5 FS Report to remediate a uranium plume within the Great Miami Aquifer. Figure 3 illustrates the location of each of the 28 wells proposed in the FS Report for the overall remediation strategy. The South Field Extraction System consists of Wells 13 through 22 in Figure 3. As a result of over 10 recent modeling simulations evaluating reinjection, Location 17 was moved north of the storm sewer outfall ditch. An overview of the reinjection modeling process was presented to the EPA and OEPA at the May 3 meeting in Chicago.

Stage 1 Evaluation - Feasibility

The FS modeling was conducted in two stages. The objective of the first stage was to provide a reasonable yet conservative estimate of the number of wells, pumping rate, and duration of pumping needed to remediate the Great Miami Aquifer to 20 μg/L of uranium. Extraction scenarios were modeled to determine the relative effects of varying the numbers, pumping rates, and locations of extraction wells. One constraint placed upon the modeling exercise was that the maximum pumping rate of each extraction well could not exceed 500 gpm. Additional constraints are presented in Appendix F of the Operable Unit 5 FS Report (DOE 1995a, Appendix F, Section 7.2).

Table 1 presents a summary of the representative extraction well patterns which were evaluated as part of the FS. Not all of these are included in the FS Report. Well-location maps, pumping schedules, capture-zone maps and particle-path maps for each well pattern listed in Table 1 are provided in Appendix I of this attachment.

Extraction scenarios presented in the FS Report were developed based on plume location, flow patterns, model analysis, and capture-zone analysis. Three scenarios were formulated and presented in the FS Report with unique well locations being pumped at two different pumping rates (7500 and 6300 gpm) to make a total of six scenarios. The pumping rate was further reduced to 4000 gpm during Stage 2 of the FS modeling, as discussed in the next section. Each Stage 1 scenario was progressively refined based upon the results of the previous scenarios. For analysis purposes, wells within these scenarios were grouped into four extraction systems based on location within aquifer zones (DOE 1995a, Appendix F, Section 7.2.5 and Figure F.7-8). A minimum of 18 and a maximum of 30 extraction wells were simulated (including the South Plume recovery wells).

Evaluation criteria for the first stage of FS modeling focused on removal rate, system efficiency, distribution of remaining uranium, and the average concentration of each modeled extraction scenario (DOE 1995a, Appendix F, Section 7.2.2). Initial Great Miami Aquifer uranium concentrations used in the modeling were conservatively developed from five different sources (DOE 1995a, Appendix F, Section 7.2.4 and Figure F.7-3). Other contaminants of concern were also modeled (DOE 1995a, Appendix F, Figures F.7-9 through F.7-14).

A summary of the results of the six modeled extraction scenarios is provided in Table 2. Scenario 3B, judged best at meeting the selection criteria, reduces maximum uranium concentrations to below 20 μg/L in 28 years and was selected because it has the highest efficiency. After 40 years the maximum uranium concentration is 8.1 μg/L and 87 percent of the uranium plume (17,598 pounds of uranium) has been removed from the Great Miami Aquifer, as shown in Figure 4. Predicted water table contours and additional drawdown for Scenario 3B are provided in Figures 5 and 6 respectively.

Stage 2 Evaluation - Optimization

The second stage of FS modeling was conducted to further optimize Scenario 3B and to evaluate treatment strategies for extracted groundwater. Regulatory requirements include restoring the site-contaminated portion of the Great Miami Aquifer to maximum contaminant levels or equivalent protective standards within a reasonable time frame; additional regulatory requirements are presented in the Operable Unit 5 FS Report (DOE 1995a, Appendix F, Section 8.1.3). Optimization also had to consider and integrate soil cleanups planned as part of the overall site remediation proposal. As documented in Section F.8 of the FS Report, the optimization first focused on two different pumping options (time-varying or sequential pumping rates). In the time-varying option, well locations were fixed according to Scenario 3B. The overall pumping rate over time was reduced as areas were cleaned up or a constant overall pumping rate was maintained but rates were redistributed as concentrations in areas fell below remediation goals. In the sequential option a lower overall pumping rate was imposed and groundwater was sequentially extracted from different areas of the site, considering the soil remediation schedule. One case from each of the two pumping options (time-varying [called Case V4] and sequential [called Case S2]) was selected for more detailed analysis. Particle tracking was used to define horizontal and vertical capture zones for these two pumping options.

Revised approaches for groundwater treatment included looking at no treatment, treating groundwater above 5 μg/L uranium concentration, treating groundwater above 20 μg/L uranium concentration, treating groundwater above 20 μg/L uranium concentration at the wellhead up to a maximum treatment capacity of 800 gpm, and treating groundwater above 20 μg/L uranium concentration at the wellhead up to a maximum treatment capacity of 1500 gpm. The two selected pumping options (Cases V4 and S2) were combined with the five treatment options to create 10 different options for detailed analysis. The 10 options were evaluated against each other based on hydraulic impacts, treatment capacity and efficiency, impact to the Great Miami River, and cost. Additional information on the evaluation criteria is provided in the Operable Unit 5 FS Report (DOE 1995a, Appendix F, Section 8.1.4). Table 3 summarizes the performance of the 10 remediation options (DOE 1995a, Appendix F, Section 8.4).

Case S2-V was selected as the recommended groundwater remediation option. This option consists of four extraction systems (a total of 28 wells) pumping up to a maximum of 4000 gpm for 28 years (Figure 3). Different plume areas are sequentially pumped under this option. As areas of the aquifer are remediated to the 20 μg/L cleanup level, extraction systems are turned off and pumping rates redistributed to other areas. During later stages of remediation, the extraction rates are reduced. Individual well pumping rates vary from 160 to 500 gpm. Recovered groundwater with uranium concentrations exceeding 20 μg/L is treated for uranium removal before discharge to the Great Miami River up to a treatment capacity of 1500 gpm. The highest uranium concentrations are treated first. All other recovered groundwater is discharged directly to the Great Miami River.

Horizontal and vertical capture zone plots for Case S2-V are provided in Figures 7 and 8, respectively. Each figure shows a capture zone for a retardation of 2.23 and 11.8. In comparing the spatial extent of the capture zones depicted in Figure 7 and the initial distribution of the uranium plumes depicted in Figures 1 and 2, the capture zones cover the areas with the bulk of uranium contamination.

Post-FS Report Confirmation

An aquifer pumping test was conducted following the completion of the Operable Unit 5 FS Report. Horizontal and vertical hydraulic conductivity estimates made from analyzing the pumping test data indicate that the model is adequately calibrated for hydraulic conductivity in the South Field extraction area. Water quality data collected during the installation of pumping test wells confirm that the uranium contamination is located where the RI concluded it should be. Uranium K_d estimates made from groundwater and soil data indicate that the K_d range used in the groundwater modeling is appropriate.

The final extraction well locations (see Figure 1 or 2), fine tuned through the long iterative modeling process described briefly above, have been surveyed in the field and positioned to the topography to make the drilling feasible. A few of the locations have been changed slightly to accommodate topography and soil remediation projects which are planned for the area. One of the extraction wells was relocated to the north to potentially accommodate the reinjection option. Modeling indicates that the extraction wells would not need to be moved further for reinjection purposes.

Conclusion

The location of the extraction wells for the South Field Extraction System have been optimized and the optimization allows for expansion and the supplemental use of reinjection. Regardless of the degree of reinjection which may be added to the extraction operation, the location of these extraction wells will not change. The locations were selected through an iterative modeling process that has involved numerous different modeling scenarios. The locations have been adjusted to accommodate topography and soil remediation schedules.

Optimization conducted for the FS used the well locations identified in Scenario 3B, which does not provide for any additional off-property extraction wells. Adding more off-property extraction wells, as well as the option to add more on-property extraction wells, will be kept open.

TABLE 1
SUMMARY TABLE OF REPRESENTATIVE EXTRACTION WELL PATTERNS EVALUATED FOR THE GREAT MIAMI AQUIFER REMEDIATION

ID	Description	Wells On-Property	Wells Off-Property	Original Objective[a]	Evaluation[b]	Required Improvements
1	5 existing South Plume wells (Fig. 1-1 to 1-4, & Table 1-1*)	0	5	A	1,2	I,II
2a	5 wells along Willey Road, 5 existing South Plume wells (Fig. 2a-1 to 2a-3, & Table 2a-1*)	5	5	A	1,2,3	I,II
2b	4 wells along Willey Road, 1 well along south acess road, 5 existing South Plume wells (Fig. 2b-1 to 2b-5, & Table 2b-1*)	5	5	A	1,2,3	I,II
3	4 wells downgradient of WPA, 5 wells downgradient of SSOD 5 existing South Plume wells (Fig. 3-1 to 3-2, & Table 3-1*)	9	5	B,D	1,2,3	I,II
4a	4 wells downgradient of WPA 4 wells downgradient of SSOD 3 wells east of South Field 5 existing South Plume wells (Fig. 4a-1 to 4a-2, & Table 4a-1*)	11	5	B,D	1,2,3	I,II
4b	Same as 4, but with increased pumping rates (Fig. 4b-1 to 4b-2, & Table 4b-1*)	11	5	B,D	1,2,3,4	I,II,I
5	4 wells downgradient of WPA 1 well in WPA 2 wells in South Field 4 wells along SSOD 3 wells north of Willey Road 5 existing South Plume Wells (Fig 5-1 to 5-5, & Table 5-1*)	14	5	B	1,3	I,II,IV
6	Same as 5, but 1 well added north of SSOD, 2 wells added south of SSOD, 1 well added along the south access road (Fig. 6-1 to 6-5, & Table 6-1*)	18	5	B	1,3	I,IV
7	Same as 6, but 1 well added north of Willey Road, (Fig. 7-1 to 7-5, & Table 7-1*)	19	5	B	1,3	I,IV,VI
8	Same as 7, but 1 well added north of Willey Road moved to west, (Fig. 8-1 to 8-5, & Table 8-1*)	19	5	B	1,3	I,IV,VI
9	5 wells downgradient of WPA 1 well north of SSOD 2 wells south of SSOD 3 wells north of Willey Road 1 well in Production Area 1 new off-property well 5 existing South Plume Wells (Fig. 9-1 to 9-3*)	12	6	B,E	1,2,3	I,II,IV

TABLE 1
(Continued)

ID	Description	Wells On-Property	Wells Off-Property	Original Objective[a]	Evaluation[b]	Required Improvements[c]
10	6 wells downgradient of WPA 1 well in WPA 1 well in OU2 2 wells north of SSOD 7 wells south of SSOD 5 wells north of Willey Road 2 new off-property wells 1 well in production area 5 existing South Plume Wells (Fig. 10-1 to 10-3*)	23	7	B,E	3,5	VI
11	Same as 10, but remove 2 new off-property wells (Fig. 11-1 to 11-3*)	23	5	B	3,5	VI
12	6 wells downgradient of WPA 1 well in WPA 3 wells north of SSOD 9 wells south of SSOD 4 shallow along Willey Road 2 deep along Willey Road 1 well in production area 5 existing South Plume Wells (Fig. 12-1 to 12-3*)	26	5	C	4,5	V,VI

[a]Objective codes:
A - Containment
B - Clean up to 20 ppb
C - Clean up to 3 ppb
D - Avoid cap in place areas
E - Evaluate additional off-property wells

[b]Evaluation codes:
1 - Cleanup greater than 30 years
2 - Inadequate capture
3 - Stagnation zone concerns
4 - Excessive hydraulic impacts
5 - Acceptable

[c]Required improvements codes (what is needed to achieve cleanup to 20 ppb in a reasonable time period):
I - Additional wells in the source areas
II - Additional wells along the storm sewer outfall ditch (SSOD)
III - Additional off-property wells
IV - Shorter distances between wells
V - Lower total pumping rate
VI - Optimal operational schedule

*Figures and tables provided in Appendix I of Attachment E.

TABLE 2

SUMMARY OF SCENARIO RESULTS

Extraction Case	Total Uranium Mass Removed after 40 Years (lbs)	Uranium Removed after 40 Years (percent)	Cumulative System Efficiency after 40 Years (lbs/Mgal)	Time to Reduce Maximum Concentration Below 20 μg/L (years)	Maximum Concentration after 40 Years (ppb)
Scenario 1A	17,884	88.4	0.126	30.0	9.0
Scenario 1B	17,436	86.2	0.145	35.0	12.3
Scenario 2A	18,021	89.0	0.127	25.5	6.1
Scenario 2B	17,484	86.4	0.146	30.0	9.2
Scenario 3A	18,108	89.5	0.128	25.0	5.9
Scenario 3B	17,598	87.0	0.147	28.0	8.1

Note: Uranium removed includes both mass withdrawn with pumped groundwater and mass left in the pumping-induced vadose zone. It is assumed that the operation program (pulsed pumping) and natural infiltration will redissolve material left in the pumping-induced vadose zone and this mass will be recovered.

TABLE 3

SUMMARY OF PERFORMANCE OF EVALUATED STRATEGIES

Option	Cleanup Time (yrs)	Maximum Pumping Rate (gpm)	Removal Efficiency Aquifer (lbs/Mgal)	Maximum Required Treatment Capacity (gpm)	Time Treatment Required (yrs)	Peak Loading Treatment (lbs/yr)	Peak Loading River[a] (lbs/yr)	Maximum Blended Concentration to River[b] (ppb)
Appendix F.7 Selected alternative	30	6300	0.19[c]	6300	30	1047	138	5
Revised baseline	26	6300	0.14	6300	26	1047	138	5
V4 (I)	25	6300	0.21	0	0	0	1111	51
V4 (II)	25	6300	0.21	5300	18	1056	288	10
V4 (III)	25	6300	0.21	6300	25	1111	138	5
V4 (IV)	25	6300	0.21	800	18	363	845	31
V4(V)	25	6300	0.21	1500	18	560	647	24
S2 (I)	27	4000	0.21	0	0	0	656	71
S2 (II)	27	4000	0.21	3000	20	616	211	12
S2 (III)	27	4000	0.21	4000	27	656	87	5
S2 (IV)	27	4000	0.21	800	20	483	405	23
S2(V)	27	4000	0.21	1500	20	595	273	16

[a]Values do not include potential discharge to the Great Miami River of about 150 lbs/yr of uranium resulting from the collection, treatment, and discharge of surface water and process wastewater.
[b]Reflects highest blended treatment plant effluent and direct discharged groundwater concentration.
[c]Appendix F.7 selected alternative includes additional surface water and operable unit loading.

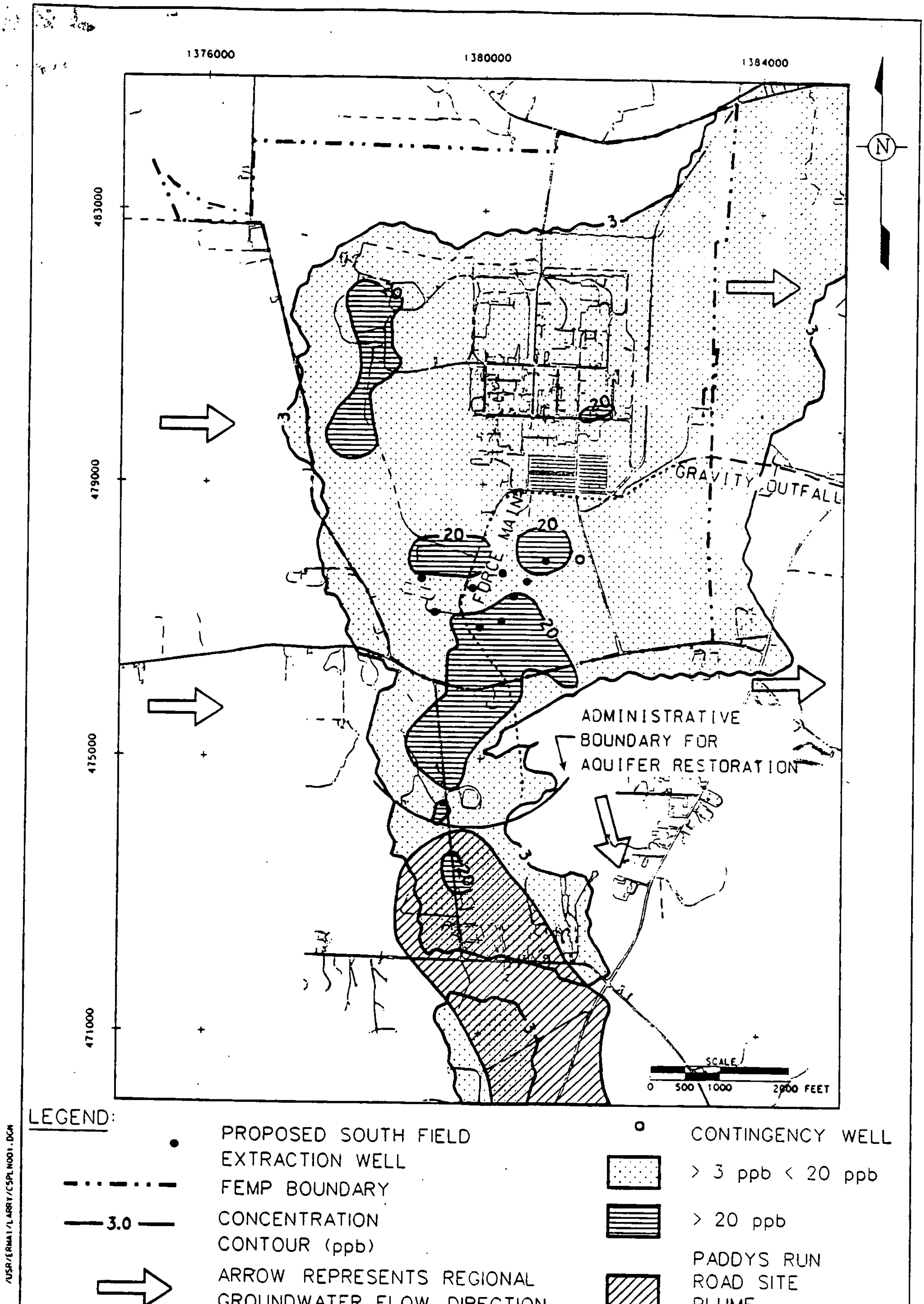
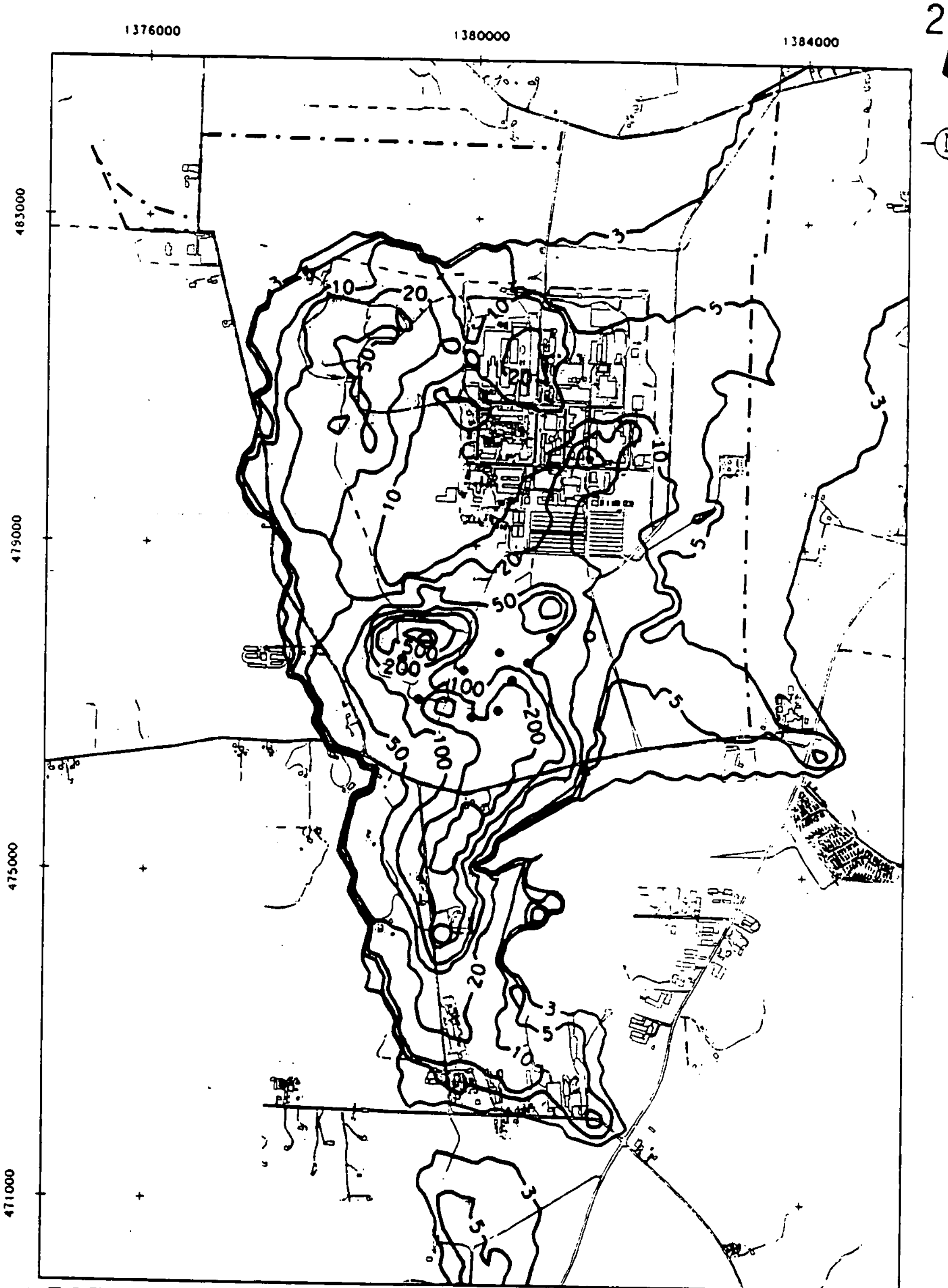


FIGURE 1. URANIUM PLUME DEFINED FROM 1993 SNAPSHOT DATA

~~000071~~



/USR/ERMA1/LARRY/C5FS007.DGN STATE PLANAR COORDINATE SYSTEM 1927

LEGEND:

● PROPOSED SOUTH FIELD EXTRACTION WELL

o CONTINGENCY WELL

— 200 — CONCENTRATION CONTOUR (ppb)

SCALE
0 500 1000 2000 FEET

DRAFT

FIGURE 2. URANIUM PLUME IN GREAT MIAMI AQUIFER USED IN MODEL

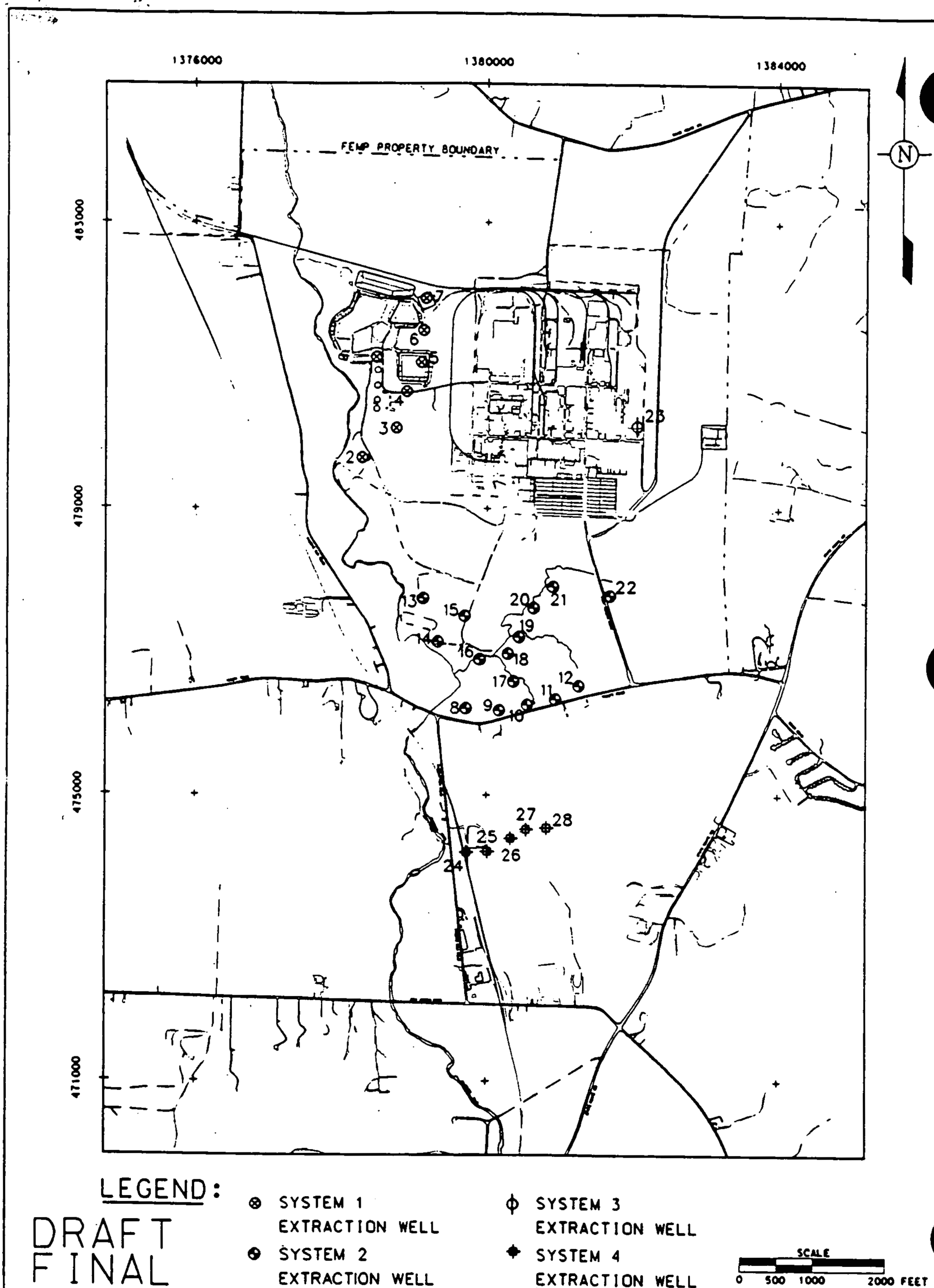


FIGURE 3. WELL CONFIGURATION FOR GROUNDWATER REMEDIATION OPTIMIZATION

[redacted]

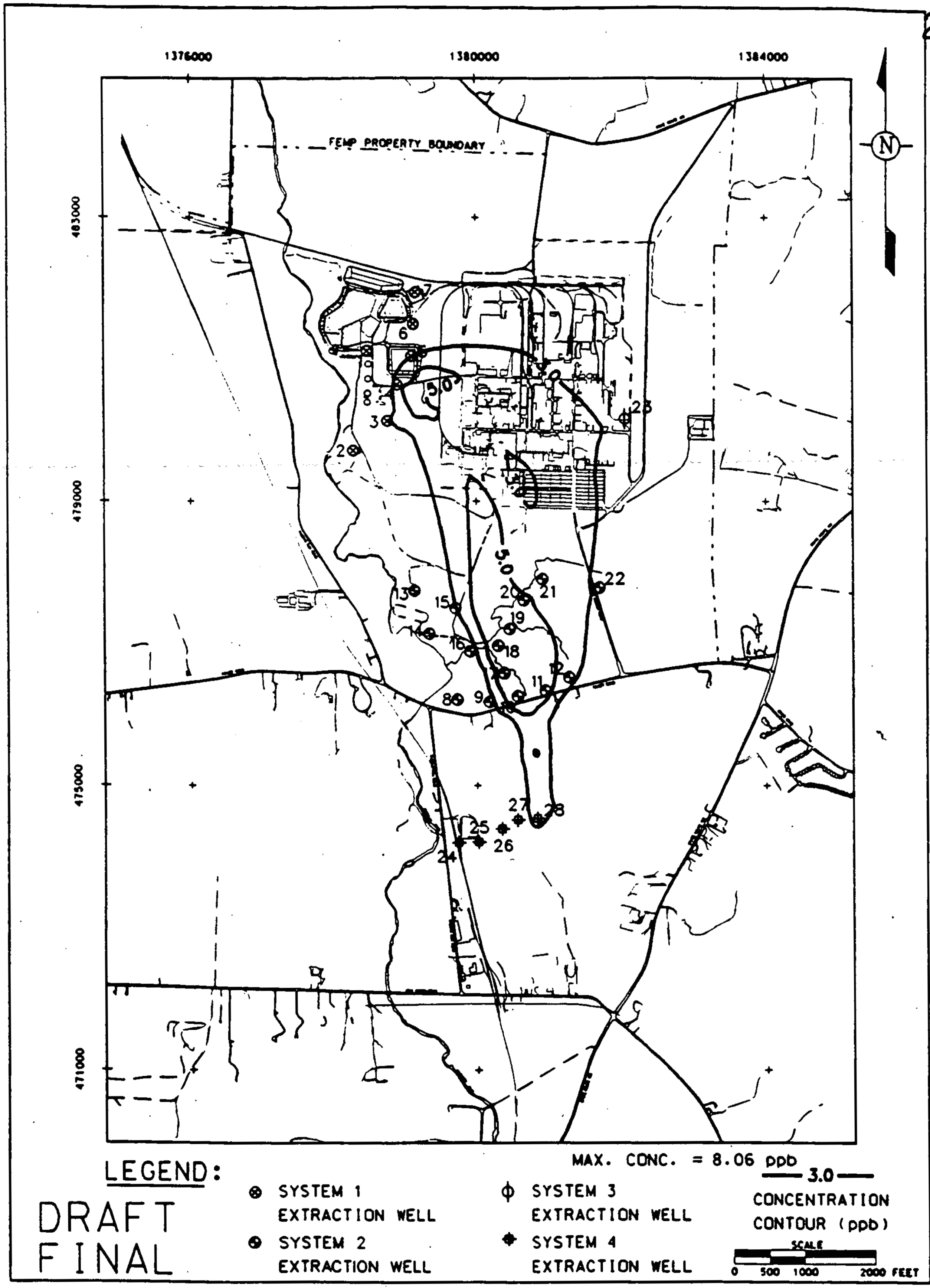


FIGURE 4. SCENARIO 3B, URANIUM CONCENTRATION CONTOURS, YEAR 40, LAYER 1

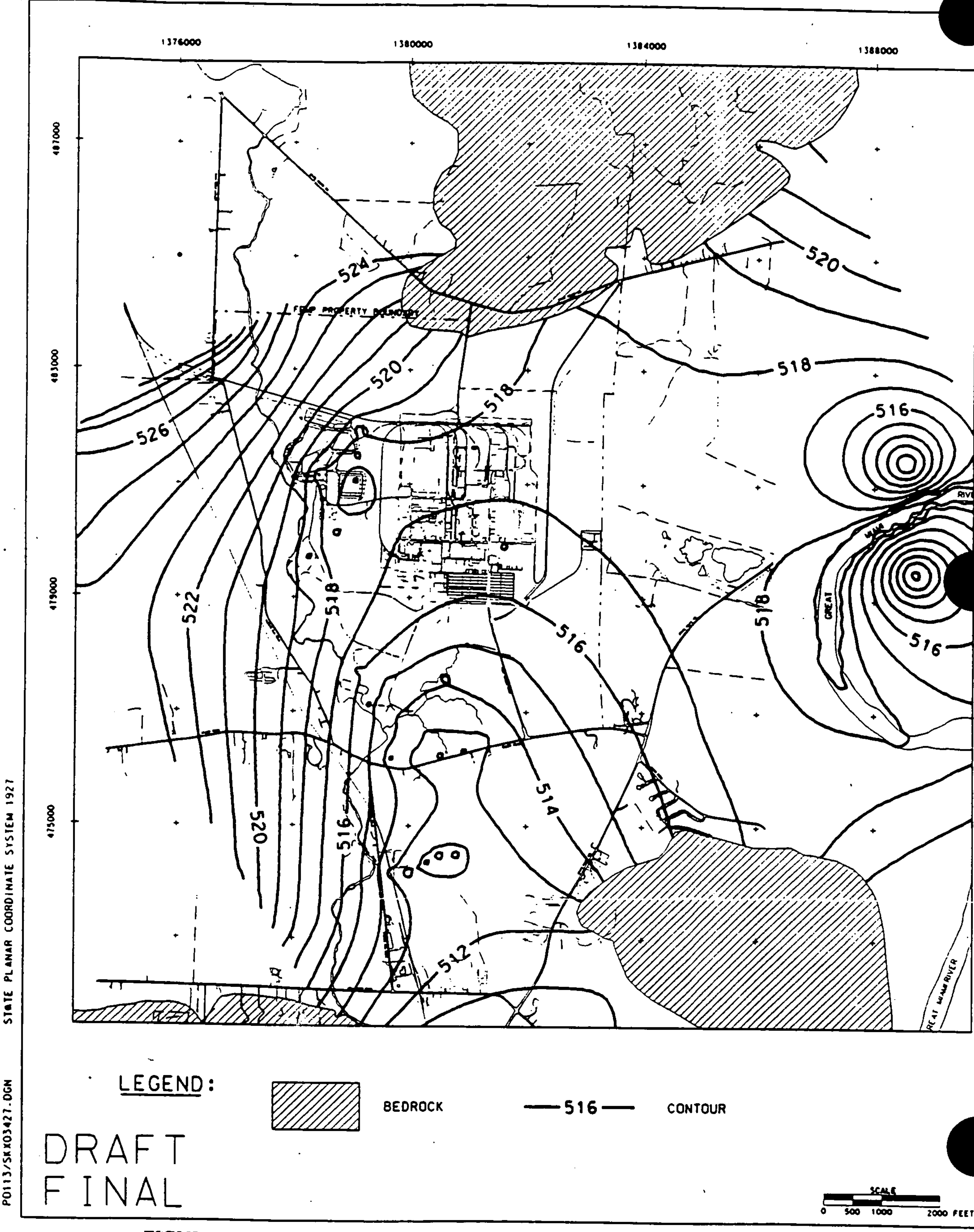
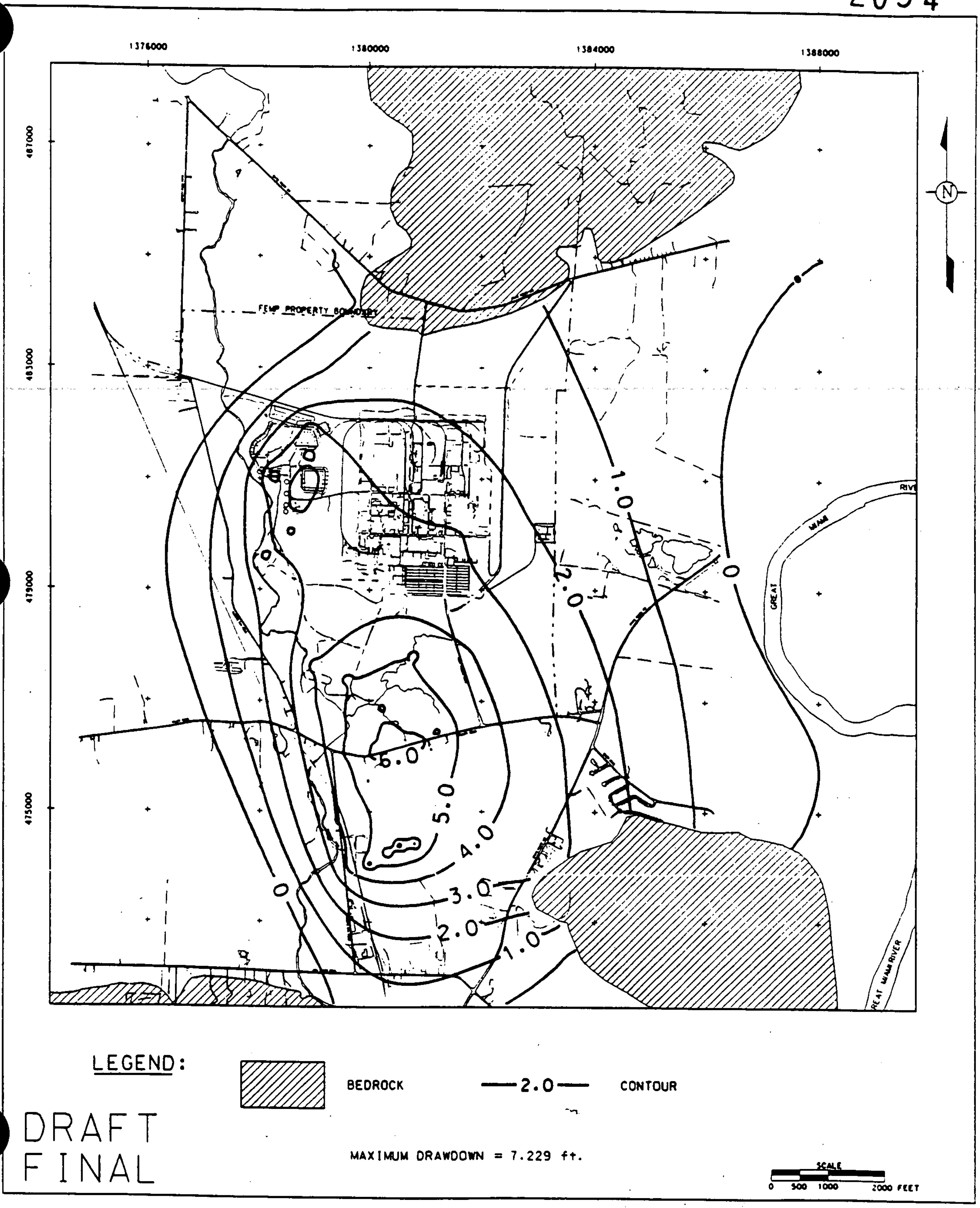
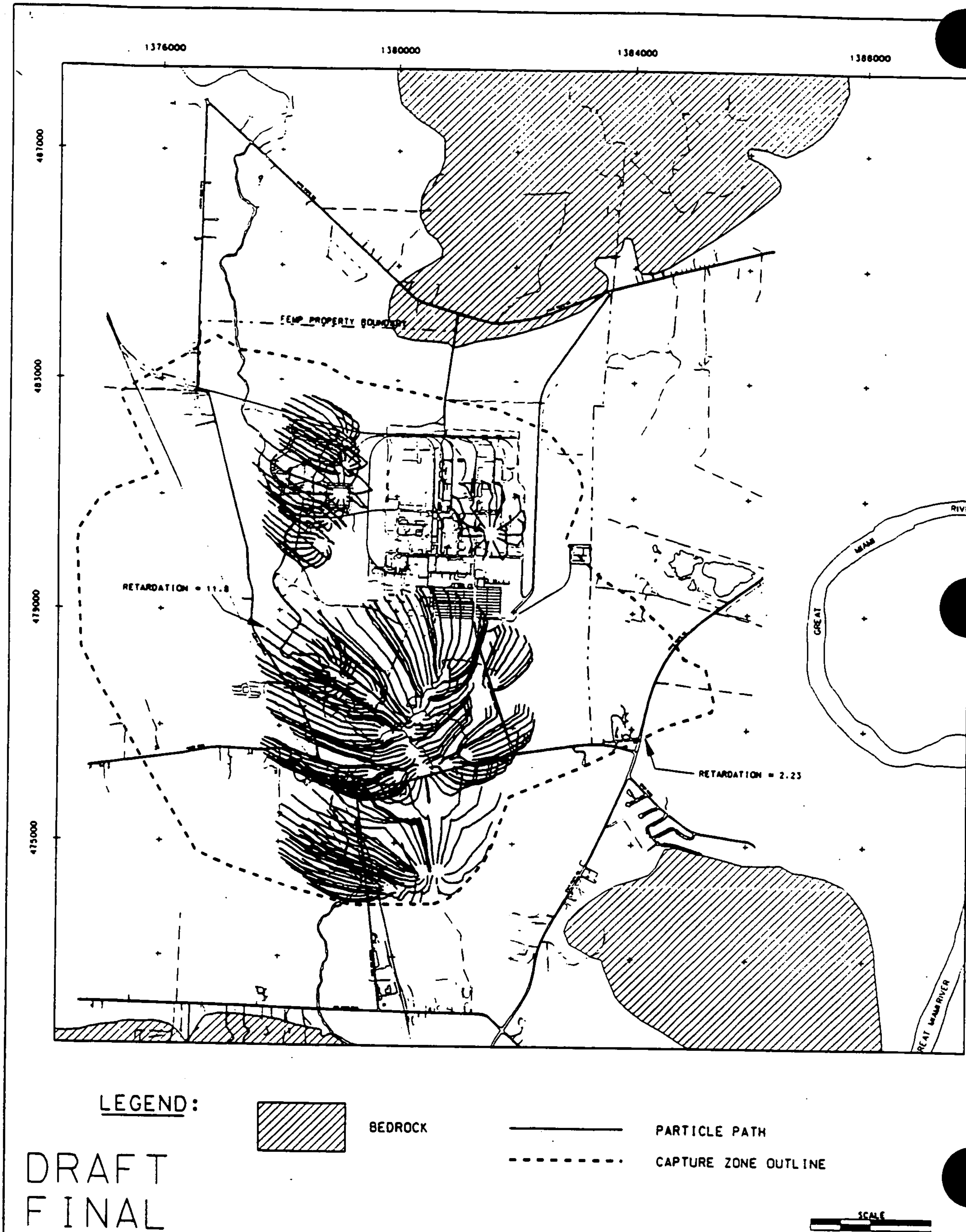


FIGURE 5. RESTORATION TO 20 ppb DESIGN - WATER TABLE CONTOURS



DRAFT
FINAL

FIGURE 6. ADDITIONAL DRAWDOWN CAUSED BY GROUNDWATER RESTORATION TO 20 ppb DESIGN PUMPING



STATE PLANAR COORDINATE SYSTEM 1927

P0113/SKX03556.DGN

DRAFT
FINAL

FIGURE 7. CAPTURE ZONE PLOT FOR CASE S2, YEARS 0 THROUGH 27 (PLANAR VIEW)

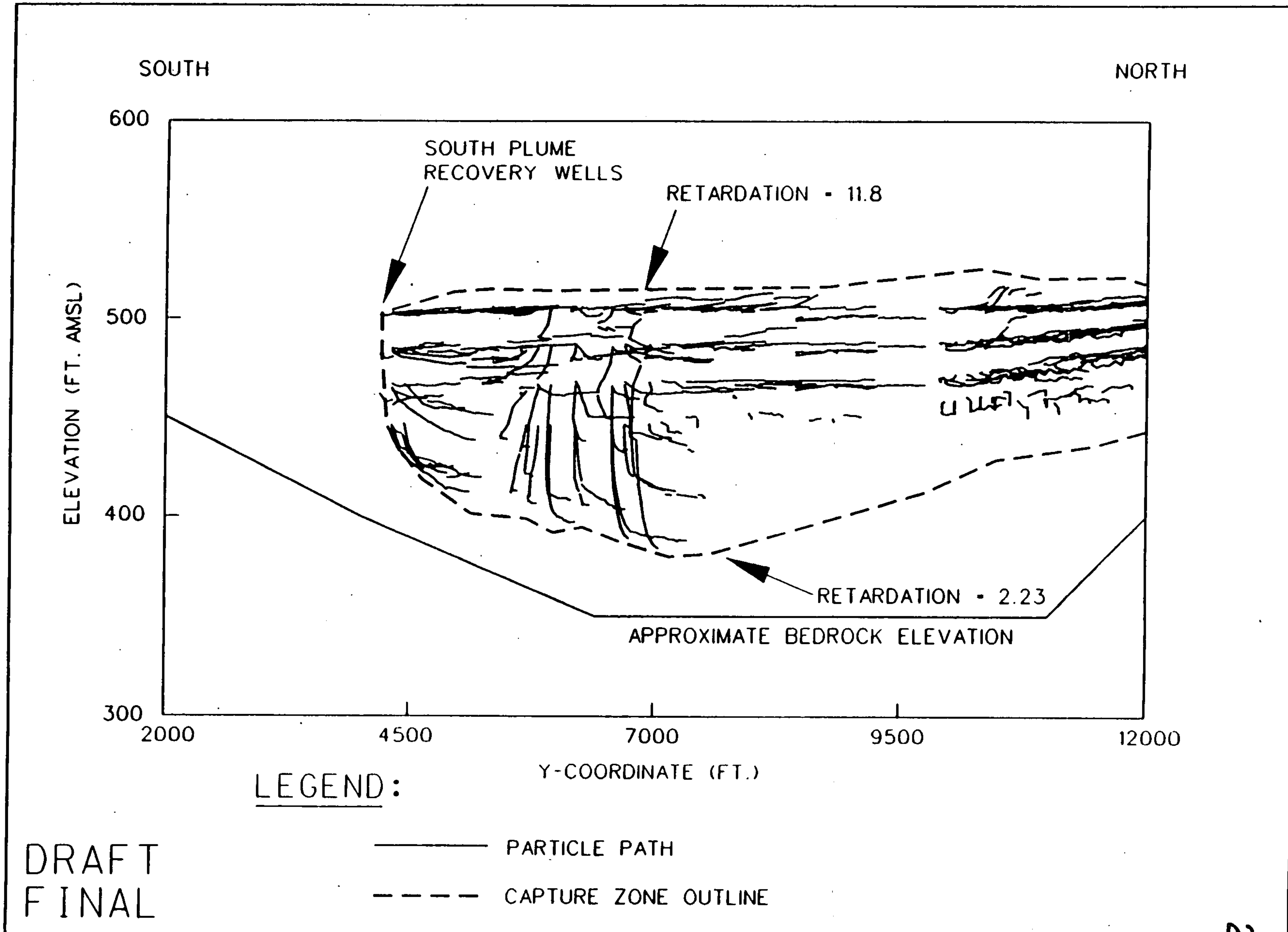


FIGURE 8. CAPTURE ZONE PLOT FOR CASE S2, YEARS 0 THROUGH 27 (N-S CROSS SECTION)

000066

2054

APPENDIX I

REPRESENTATIVE EXTRACTION WELL PATTERNS

TABLE 1-1

NO ADDITIONAL ACTION PUMPING SCHEDULE

Extraction System	Well Number	SWIFT Cell Number (I-J)	Well Pumping Rate (gpm)	Extraction System Rate (gpm)
4	1	19-36	300	
	2	21-35	300	
	3	24-35	300	
	4	26-35	300	
	5	28-34	300	1500
System Total	5			1500

TABLE 2a-1

GROUNDWATER CONTAINMENT TO 20 μg/L PUMPING SCHEDULE

Subsystem	Well Number	SWIFT Cell Number (I, J)[a]	Screened Interval Layer	Well Pumping Rate 0 to 5 Years (gpm)	Well Pumping Rate 5-75 years (gpm)
2	1	27,50	1 - 3[b]	0	300
	2	30,48	1 - 3[b]	0	200
	3	33,47	1 - 3[b]	0	200
	4	36,46	1 - 3[b]	0	200
	5	39,46	1 - 3[b]	0	200
4	6	19,36	1 - 3[b]	300	300
	7	21,35	1 - 3[b]	300	300
	8	24,35	1 - 3[b]	300	300
	9	26,35	1 - 3[b]	300	300
	10	28,34	1 - 3[b]	300	300
System Total	10			1500	2600

[a] See Figure F.7-8 for cell locations

[b] Elevation of the water table in Layer 1 is approximately 523-526 feet above mean sea level (AMSL). Elevation of the bottom of Layer 3 is approximately 442-444 feet AMSL.

TABLE 2b-1

CONTAINMENT SCENARIO, PUMPING SCHEDULE

Subsystem	Well Number	SWIFT Cell Number (I-J)	Well Pumping Rate 5-75 years (gpm)	Subsystem Rate years 5-75 (gpm)
3	1	27-50	300	
	2	31-48	200	
	3	38-46	200	
	4	46-51	200	
	5	43-44	200	1100
4	1	19-36	300^	
	2	21-35	300^	
	3	24-35	300^	
	4	26-35	300^	
	5	28-34	300^	1500
System Total	10			2600

Note: ^ South Plume Recovery System wells are pumped continuously beginning in year 0.

TABLE 3-1

SCENARIO 1, PUMPING SCHEDULE

Subsystem	Well Number	SWIFT Cell Number	Well Pumping Rate (ft^3/day)	Subsystem Rate (ft^3/day)
1	1	48-92	38400	
	2	44-87	38400	
	3	38-82	38400	
	4	34-78	38400	153600
2/3	1	23-56	40000	
	2	28-50	40000	
	3	33-48	40000	
	4	38-47	40000	
	5	46-56	40000	200000
4	1	19-36	57600	
	2	21-35	57600	
	3	24-35	57600	
	4	26-35	57600	
	5	28-34	57600	288000
System Total	14			641600

~~124~~
2054

TABLE 4a-1

SCENARIO 2, PUMPING SCHEDULE

Subsystem	Well Number	SWIFT Cell Number	Well Pumping Rate (ft^3/day)	Subsystem Rate (ft^3/day)
1	1	31-79	38400	
	2	38-82	38400	
	3	42-85	38400	
	4	46-89	38400	153600
2	1	32-58	19200	
	2	34-59	19200	
	3	35-61	19200	
	4	46-57	38400	96000
3	1	28-51	19200	
	2	39-48	38400	
	3	32-48	38400	96000
4	1	19-36	57600	
	2	21-35	57600	
	3	24-35	57600	
	4	26-35	57600	
	5	28-34	57600	288000
System Total	16			633600

TABLE 1

SCENARIO 3, PUMPING SCHEDULE

Subsystem	Well Number	SWIFT Cell Number	Rate (ft^3/day)	Subsystem Rate (ft^3/day)
1	1	31-79	38400	
	2	38-82	38400	
	3	42-85	38400	
	4	46-89	38400	153600
2	1	32-58	96000	
	2	34-59	96000	
	3	35-61	96000	
	4	46-57	96000	384000
3	1	28-51	96000	
	2	39-48	96000	
	3	32-48	96000	288000
4	1	19-36	57600	
	2	21-35	57600	
	3	24-35	57600	
	4	26-35	57600	
	5	28-34	57600	288000
System Total	16			1113600

TABLE 5-1

SCENARIO 1, PUMPING SCHEDULE

System	Well Number	SWIFT Cell Number (I-J)	Well Pumping Rate 5-35 Years (gpm)	Well Pumping Rate Years 35-75 (gpm)	Extraction System Rate Years 5-35 (gpm)	Extraction System Rate Years 35-75 (gpm)
1	1	30-78	200	0		
	2	36-81	200	0		
	3	41-84	200	0		
	4	45-88	200	0		
	5	40-91	200	0	1000	0
2	1	45-61	200	200		
	2	31-58	200	200		
	3	30-63	200	200	600	600
3	1	27-50	200	200		
	2	31-48	200	200		
	3	38-46	200	200		
	4	30-53	200	200		
	5	37-54	200	200		
	6	44-56	200	200	1200	1200
4	1	19-36	300[A]	0		
	2	21-35	300[A]	0		
	3	24-35	300[A]	0		
	4	26-35	300[A]	0		
	5	28-34	300[A]	0	1500	0
System Total	19				4300	1800

Notes:

[A] South Plume Recovery Wells pumped from 0-35 years

TABLE 6-1

SCENARIO 2, PUMPING SCHEDULE

Extraction System	Well Number	SWIFT Cell Number (I-J)	Well Pumping Rate 5-35 years (gpm)	Well Pumping Rate, years 35-75 (gpm)	Extraction System Rate years 5-35 (gpm)	Extraction System Rate years 35-75 (gpm)
1	1	30-78	150	0		
	2	36-81	150	150		
	3	41-84	150	0		
	4	45-88	150	150		
	5	40-91	150	0	750	300
2	1	45-61	100	100		
	2	31-58	200	200		
	3	30-63	200	200		
	4[A]	37-62	150	150	650	650
3	1	27-50	300	300		
	2	31-48	200	200		
	3	38-46	200	200		
	4	30-53	300	300		
	5	37-54	200	200		
	6	44-56	200	200		
	7[A]	41-56	100	100		
	8[A]	35-53	200	200		
	9[A]	46-51	200	200	1900	1900
4	1	19-36	300[B]	0		
	2	21-35	300[B]	0		
	3	24-35	300[B]	0		
	4	26-35	300[B]	0		
	5	28-34	300[B]	0	1500	0
System Total	23				4800	2850

Notes:

[A] - These wells are in addition to the Scenario 1 wells

[B] - South Plume Recovery Wells pumped from 0-35 years

TABLE 7-1

SCENARIO 3, PUMPING SCHEDULE

Extraction System	Well Number	SWIFT Cell Number (I-J)	Well Pumping Rate 5-35 years (gpm)	Well Pumping Rate, years 35-75 (gpm)	Extraction System Rate years 5-35 (gpm)	Extraction System Rate years 35-75 (gpm)
1	1	30-78	200	0		
	2	36-81	200	0		
	3	41-84	200	0		
	4	45-88	200	0		
	5	40-91	200	0	1000	0
2	1	45-61	100	0		
	2	31-58	200	200		
	3	30-63	200	0		
	4	37-62	150	0	650	200
3	1	27-50	300	300		
	2	31-48	200	200		
	3	38-46	200	200		
	4	30-53	300	0		
	5	37-54	200	0		
	6	44-56	200	0		
	7	41-56	200	0		
	8	35-53	200	0		
	9	46-51	200	200		
	10	43-44[A]	0	200	2000	1100
4	1	19-36[B]	300	0		
	2	21-35[B]	300	0		
	3	24-35[B]	300	0		
	4	26-35[B]	300	0		
	5	28-34[B]	300	0	1500	0
System Total	24				5150	1300

Notes:

[A] - Well is added to Scenario 2 wells.

[B] - South Plume Recovery Wells are pumped from 0-35 years.

TABLE 8-1

SCENARIO 4, PUMPING SCHEDULE

Extraction System	Well Number	SWIFT Cell Number (I-J)	Well Pumping Rate 5-35 years (gpm)	Well Pumping Rate, years 35-75 (gpm)	Extraction System Rate years 5-35 (gpm)	Extraction System Rate years 35-75 (gpm)
1	1	30-78	200	0		
	2	36-81	200	0		
	3	41-84	200	200		
	4	45-88	200	0		
	5	40-91	200	0	1000	200
2	1	45-61	100	0		
	2	31-58	200	0		
	3	30-63	200	0		
	4	37-62	150	0	650	200
3	1	27-50	300	100		
	2	31-48	200	200		
	3	38-46	200	200		
	4	30-53	300	0		
	5	37-54	200	0		
	6	44-56	200	0		
	7	41-56	200	0		
	8	35-53	200	0		
	9	46-51	200	200		
	10	33-47[A]	200	200	2200	1300
4	1	19-36	300[B]	0		
	2	21-35	300[B]	0		
	3	24-35	300[B]	0		
	4	26-35	300[B]	0		
	5	28-34	300[B]	0	1500	0
System Total	24				5350	1700

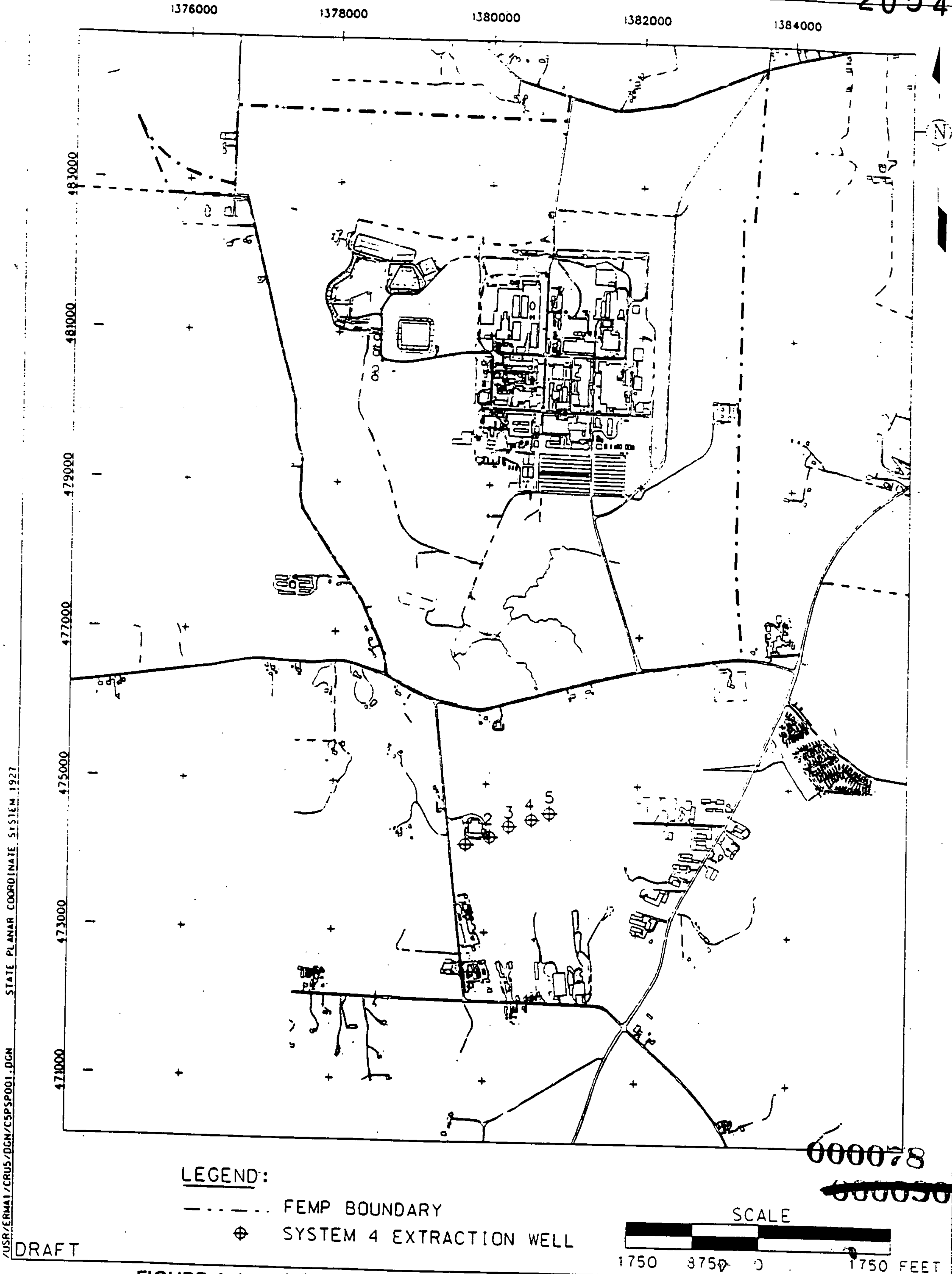
Notes:

[A] - Well is relocated from Scenario 3

[B] - South Plume Wells are pumped from 0-35 years

~~124~~

~~2054~~



000078

~~000050~~

FIGURE 1-1. NO ADDITIONAL ACTION SCENARIO, WELL LOCATIONS

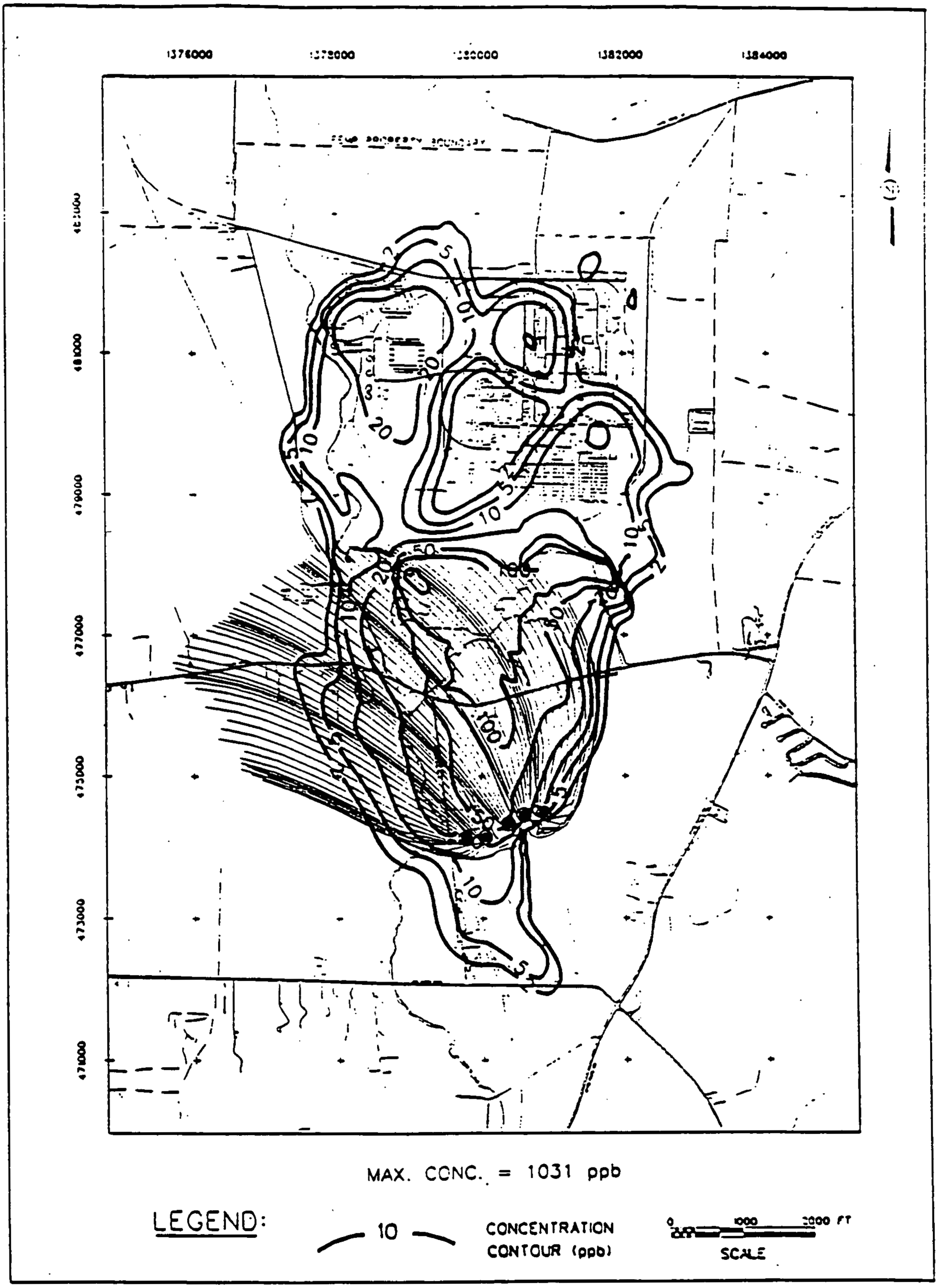


FIGURE 1-2. NO ADDITIONAL ACTION SCENARIO-CAPTURE ZONE 75 YRS.

000079

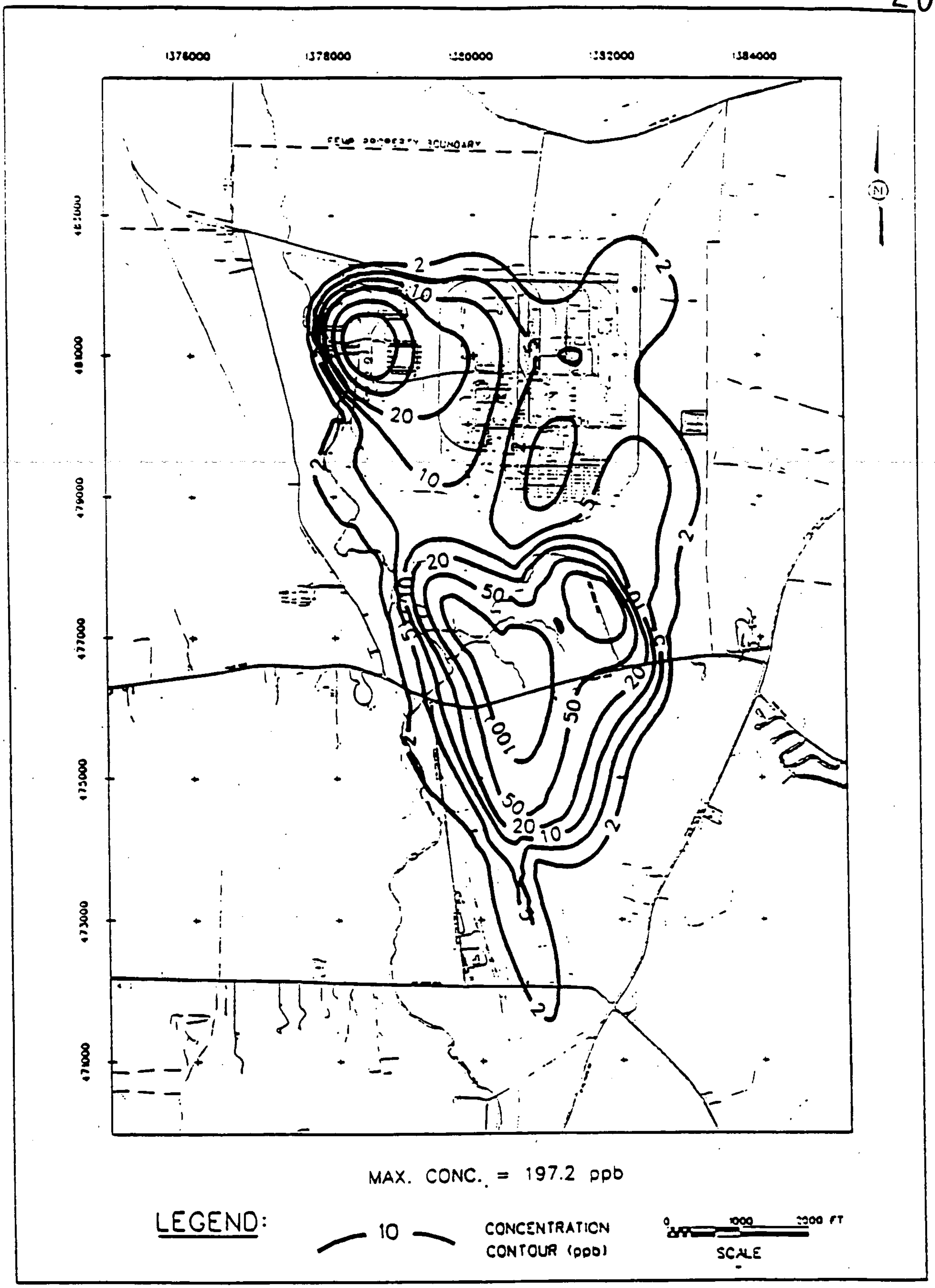


FIGURE 1-3. NO ADDITIONAL ACTION SCENARIO - CONCENTRATION CONTOURS 35 YEARS, LAYER 1

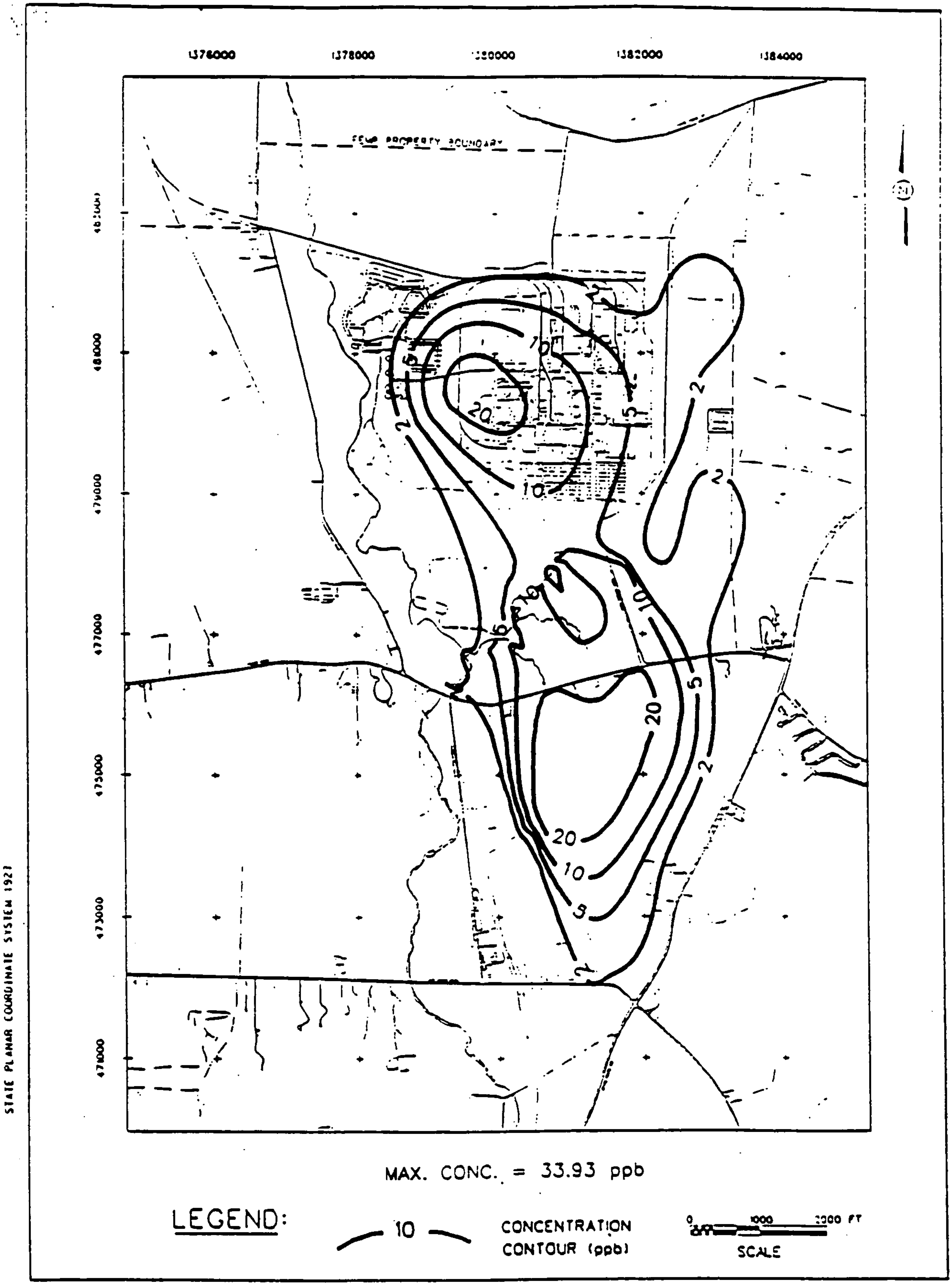
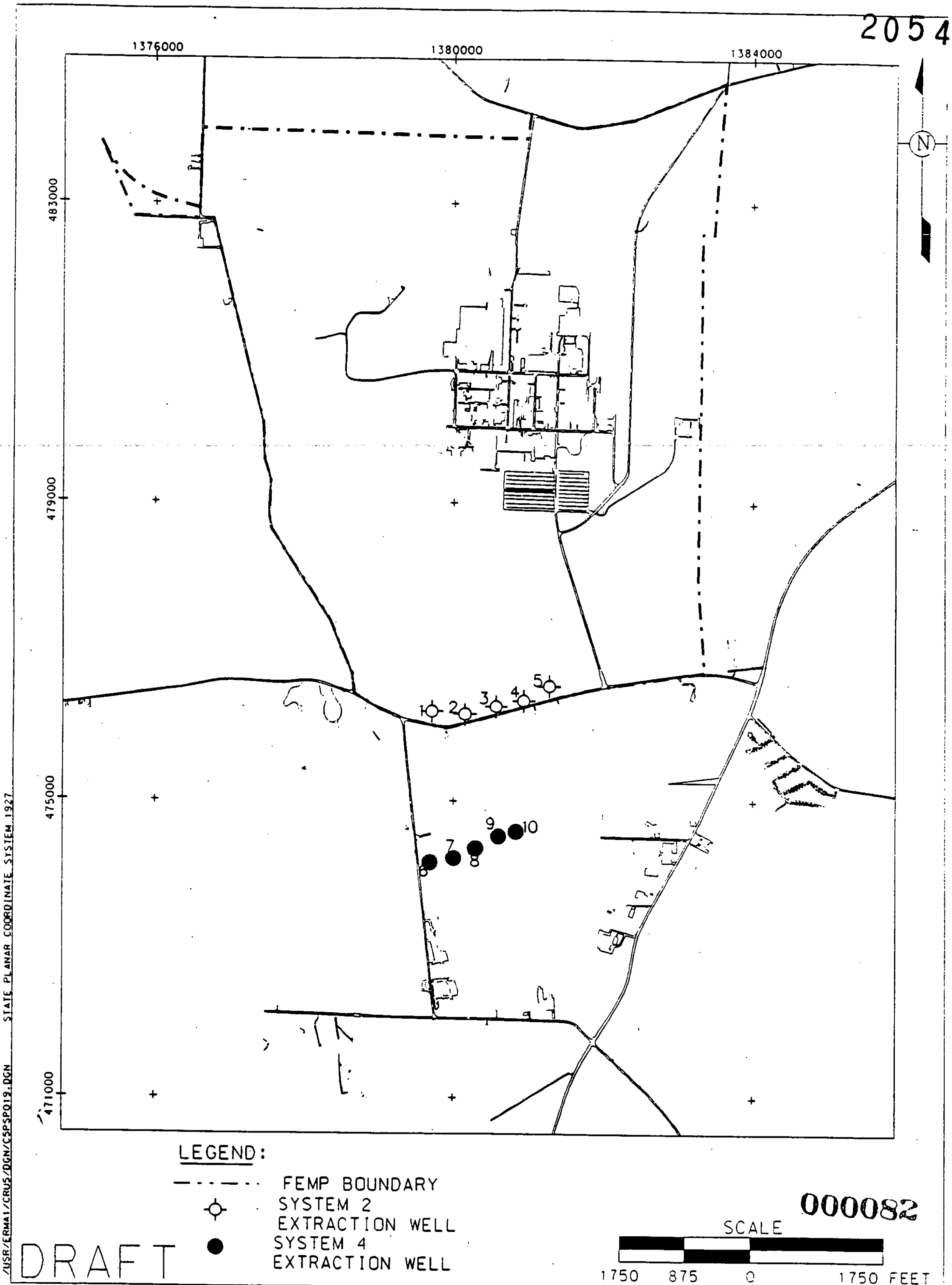


FIGURE 1-4. NO ADDITIONAL ACTION SCENARIO - CONCENTRATION CONTOURS 75 YEARS, LAYER 1

~~000032~~

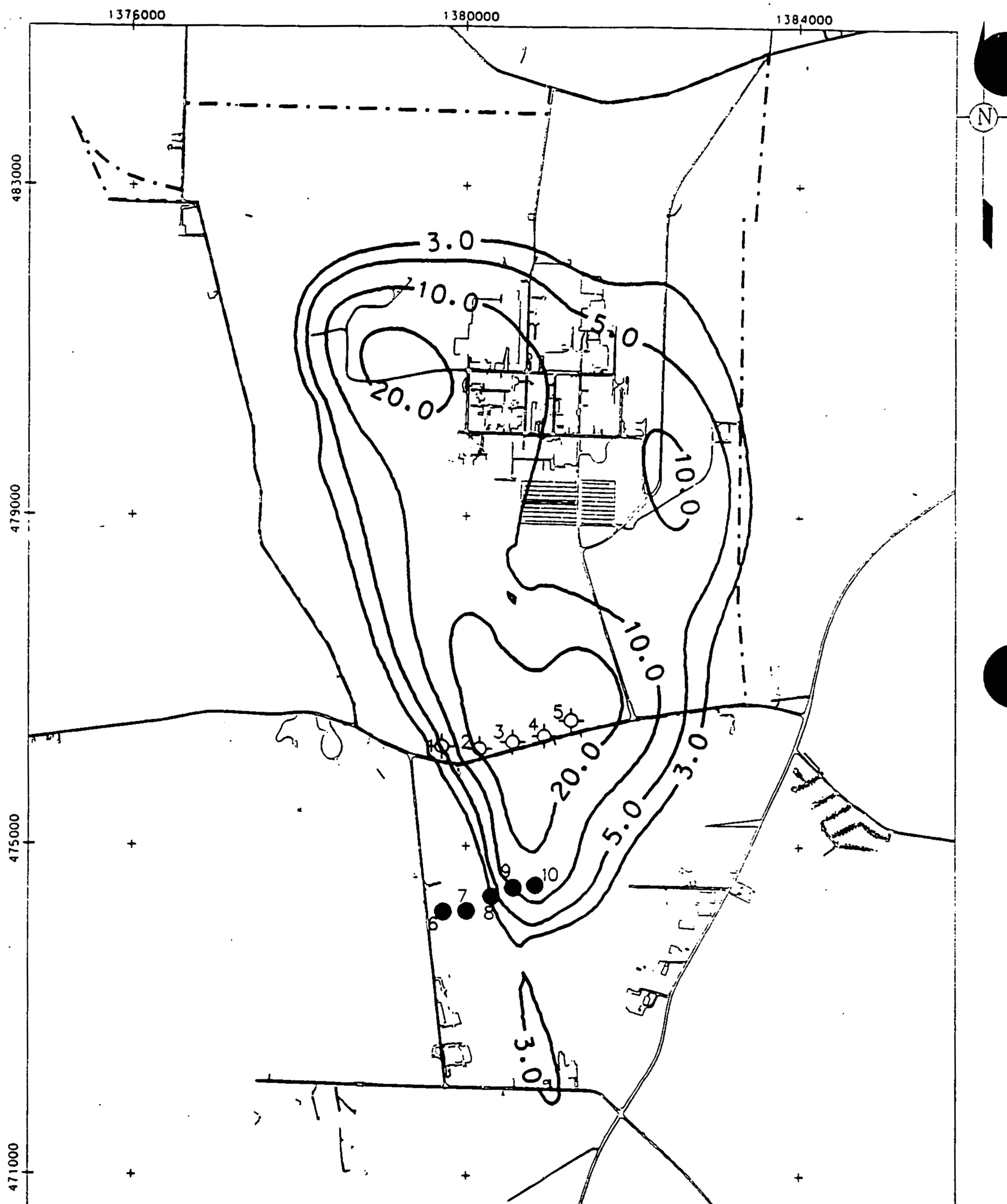
~~124~~

2054



000082

FIGURE 2a-1. GROUNDWATER CONTAINMENT TO 20 PPB WELL LOCATIONS



STATE PLANAR COORDINATE SYSTEM 1927

/USR/EMRA1/CRUS/DGN/CSPSP017.DGN

LEGEND:

- · — · FEMP BOUNDARY
- SYSTEM 2 EXTRACTION WELL
- ● SYSTEM 4 EXTRACTION WELL
- —3.0— CONCENTRATION CONTOUR (ppb)

MAX. CONC. = 38.82 ppb

SCALE

1750 875 0 1750 FEET

DRAFT

FIGURE 2a-2. GROUNDWATER CONTAINMENT TO 20 PPB, CONCENTRATION CONTOURS, YEAR 40, LAYER 1

2054

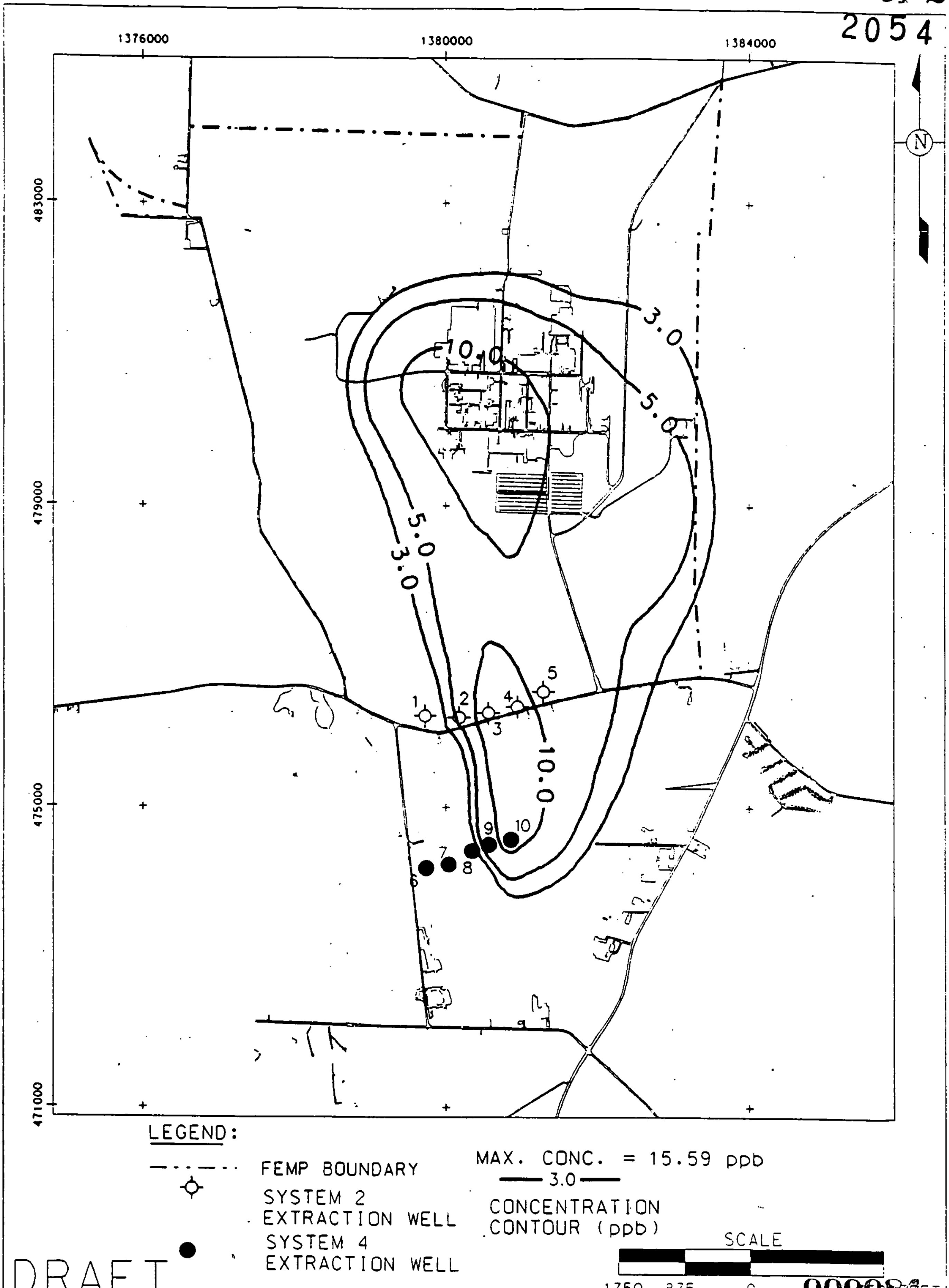


FIGURE 2a-3. GROUNDWATER CONTAINMENT TO 20 PPB CONCENTRATION CONTOURS, YEAR 60, LAYER 1

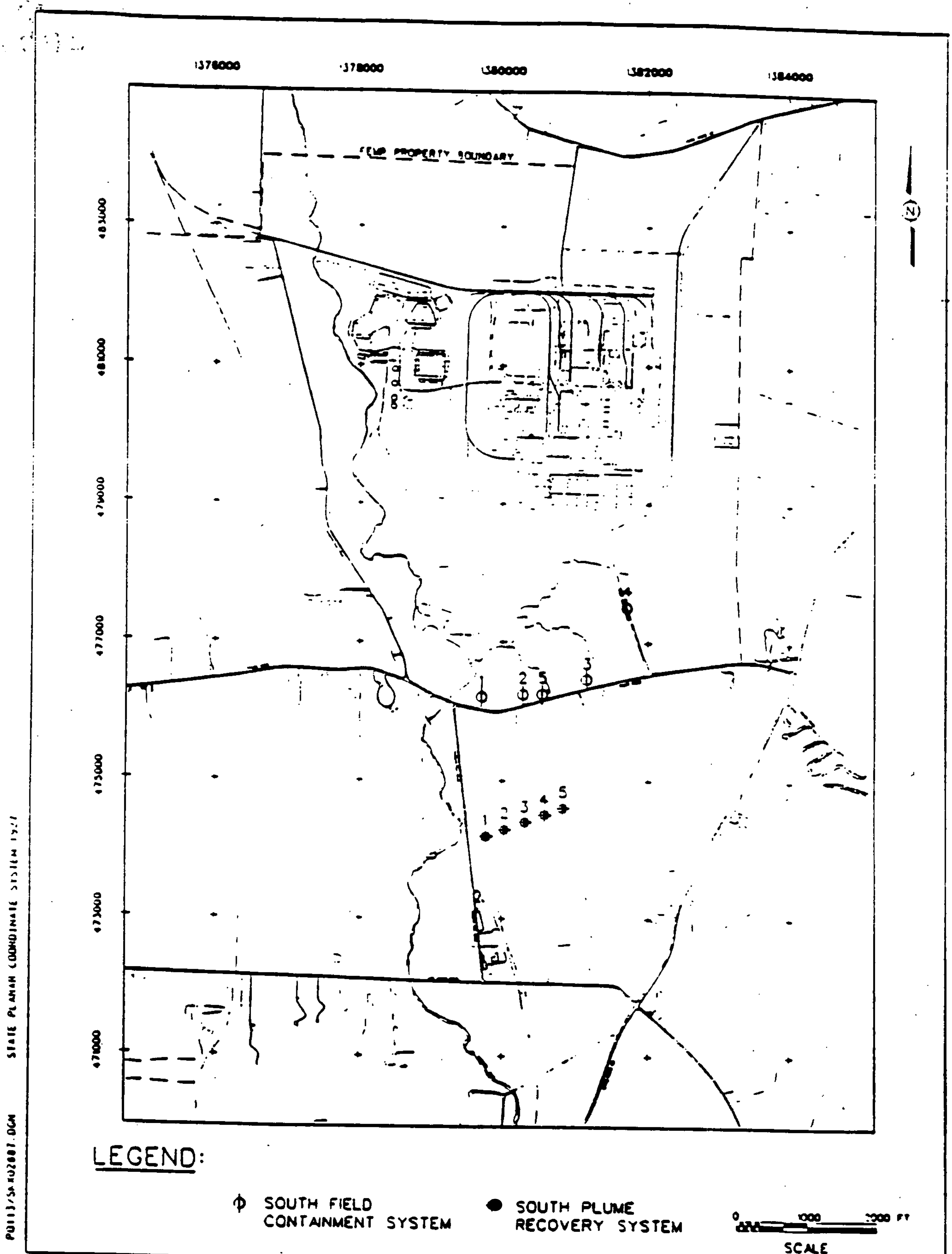


FIGURE 2b-1. CONTAINMENT SCENARIO, WELL LOCATIONS

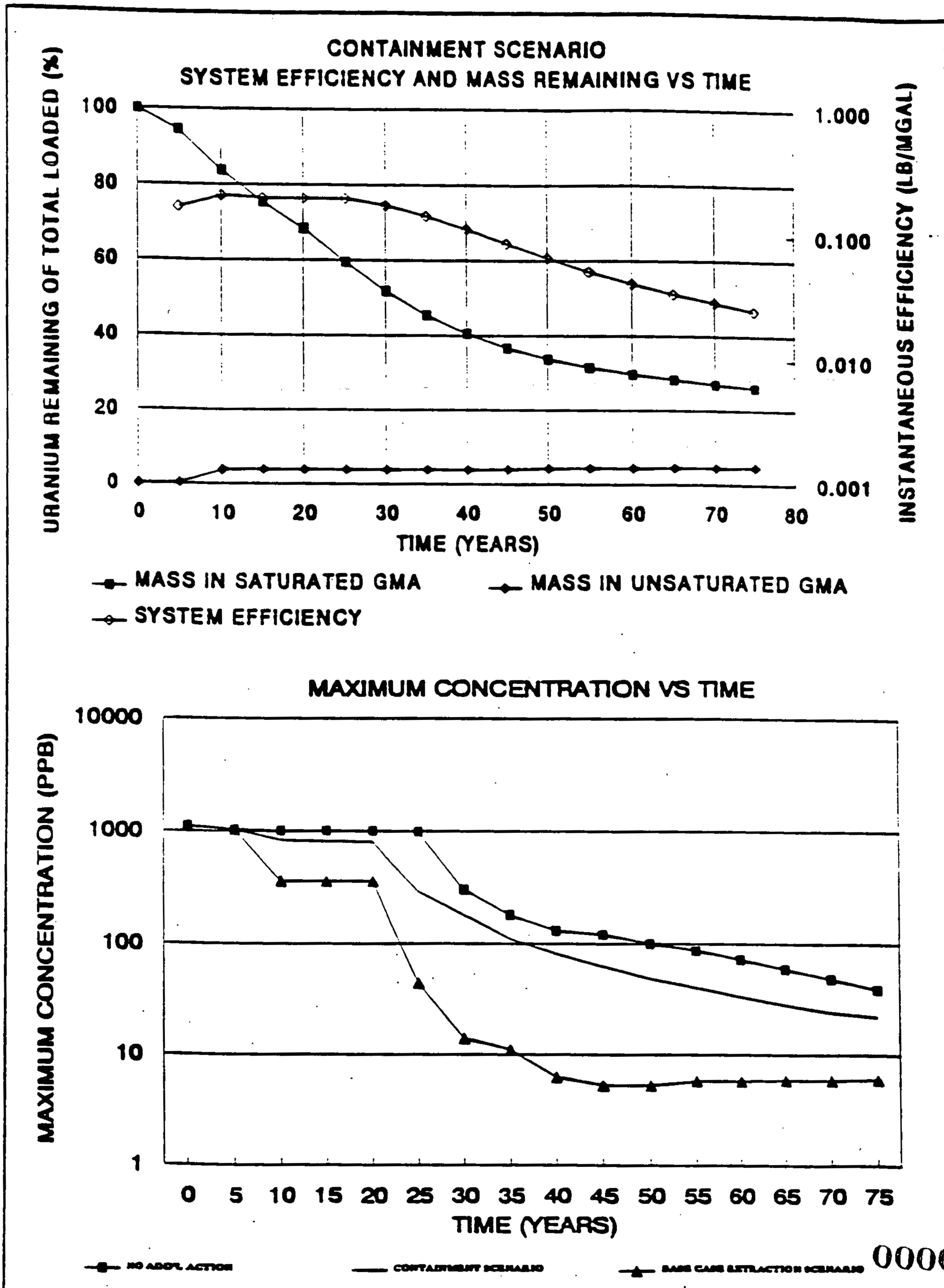


FIGURE 2b-2. CONTAINMENT SCENARIO, SYSTEM PERFORMANCE

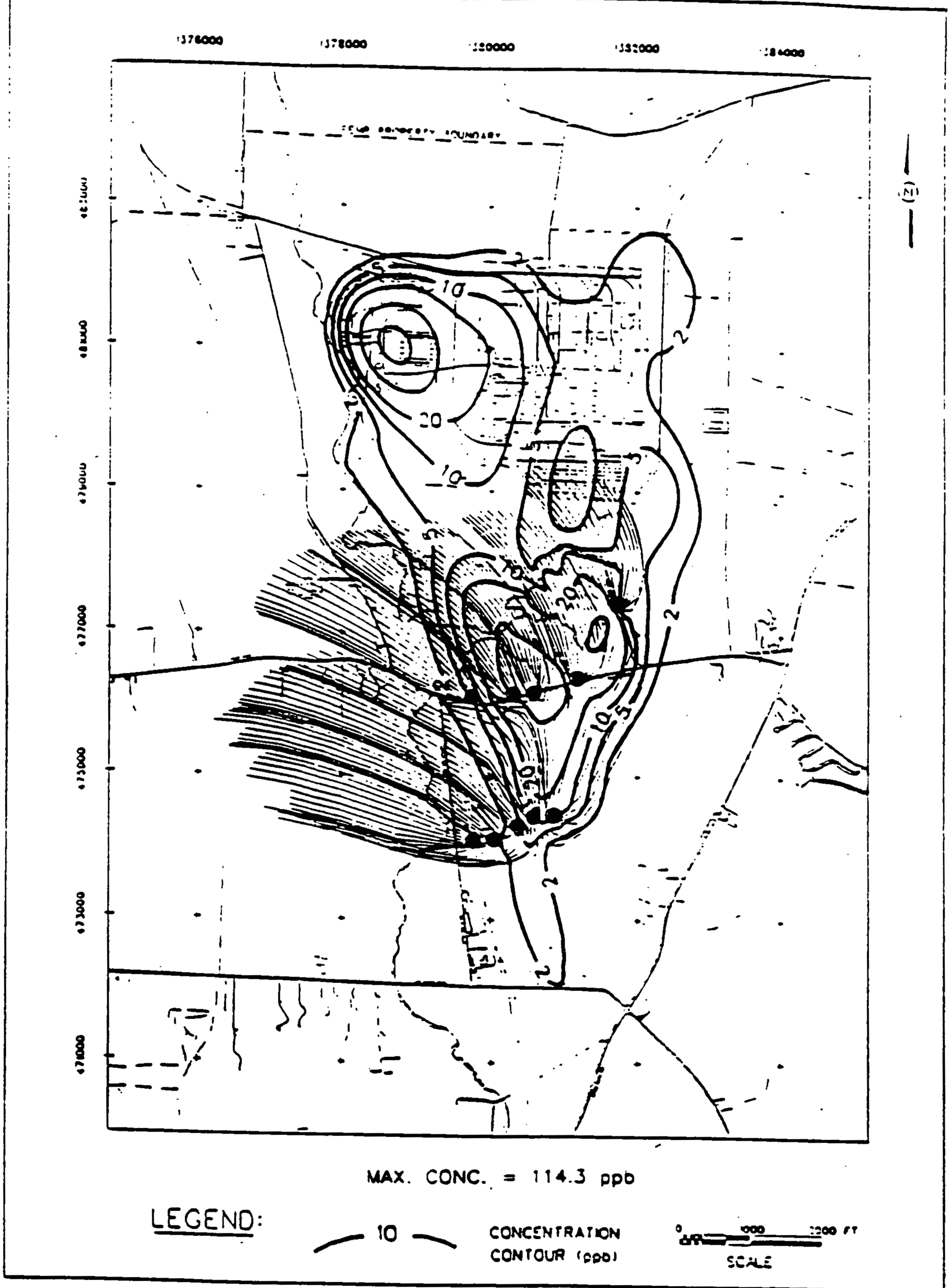


FIGURE 2b-3. GMA CONTAINMENT SCENARIO-CAPTURE ZONE 75 YRS.

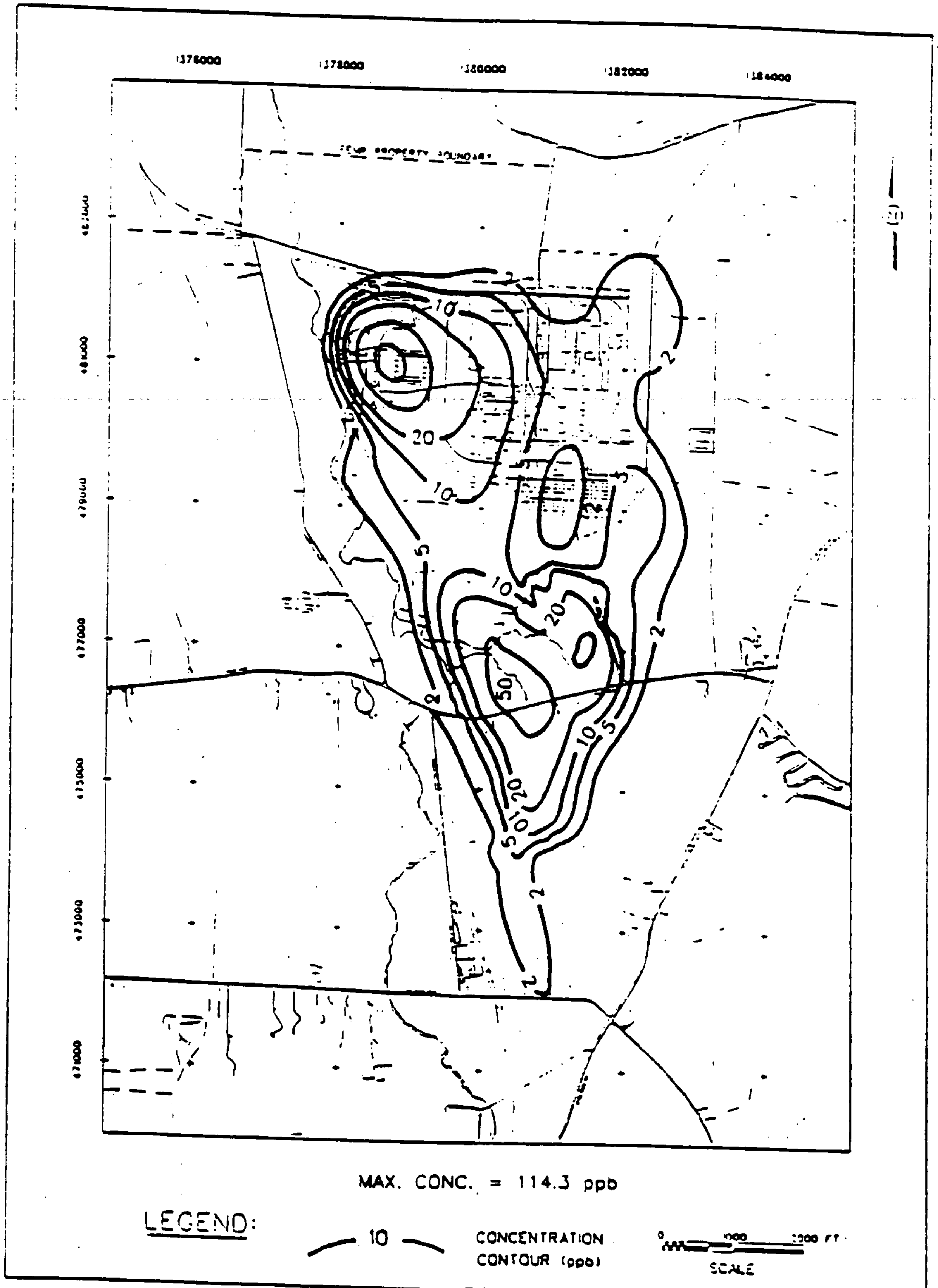


FIGURE 2b-4. GMA CONTAINMENT SCENARIO-CONCENTRATION CONTOURS 35 YRS., LAYER 1

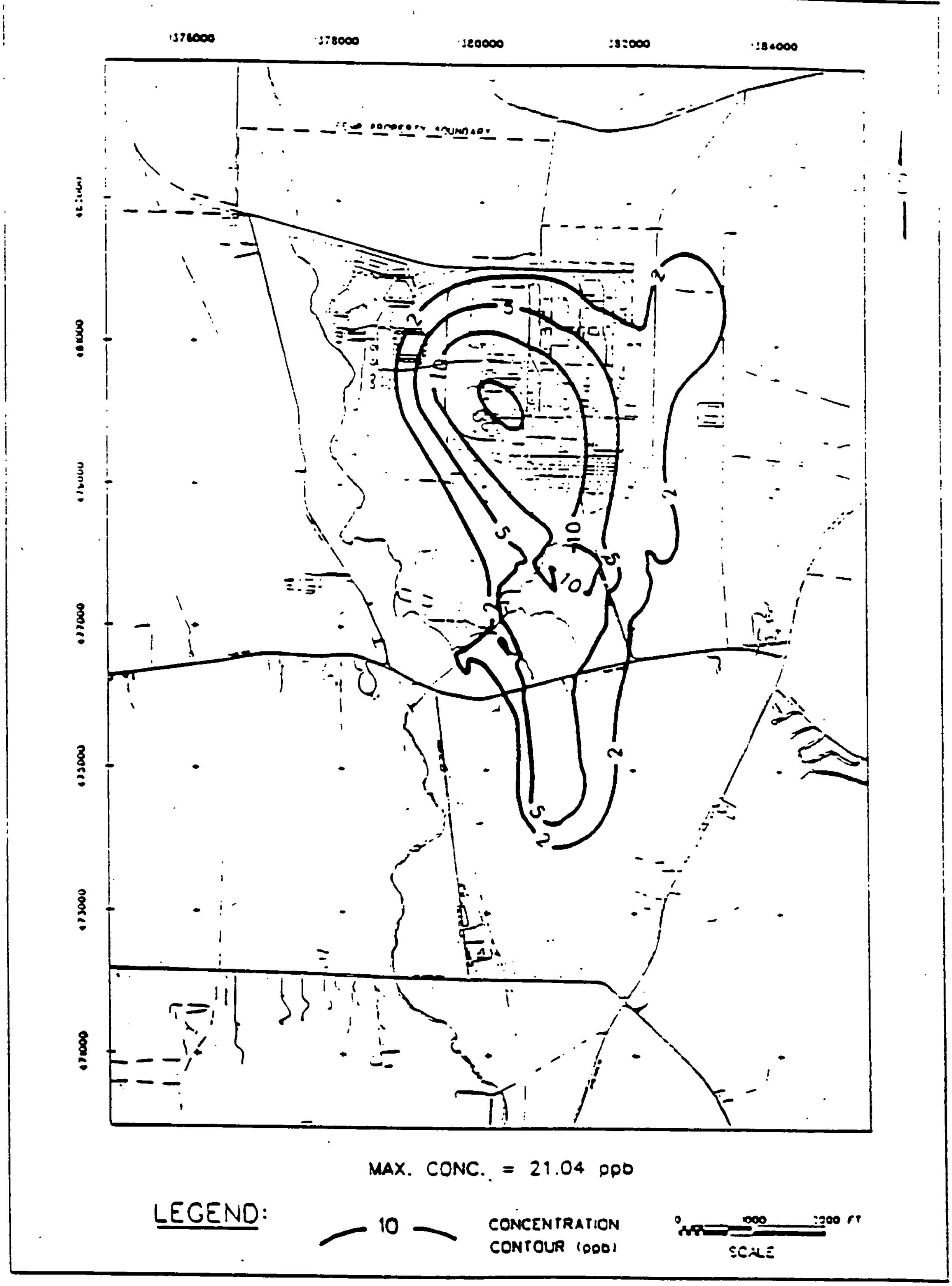


FIGURE 2b-5. GMA CONTAINMENT SCENARIO-CONCENTRATION CONTOURS 75 YRS., LAYER 1

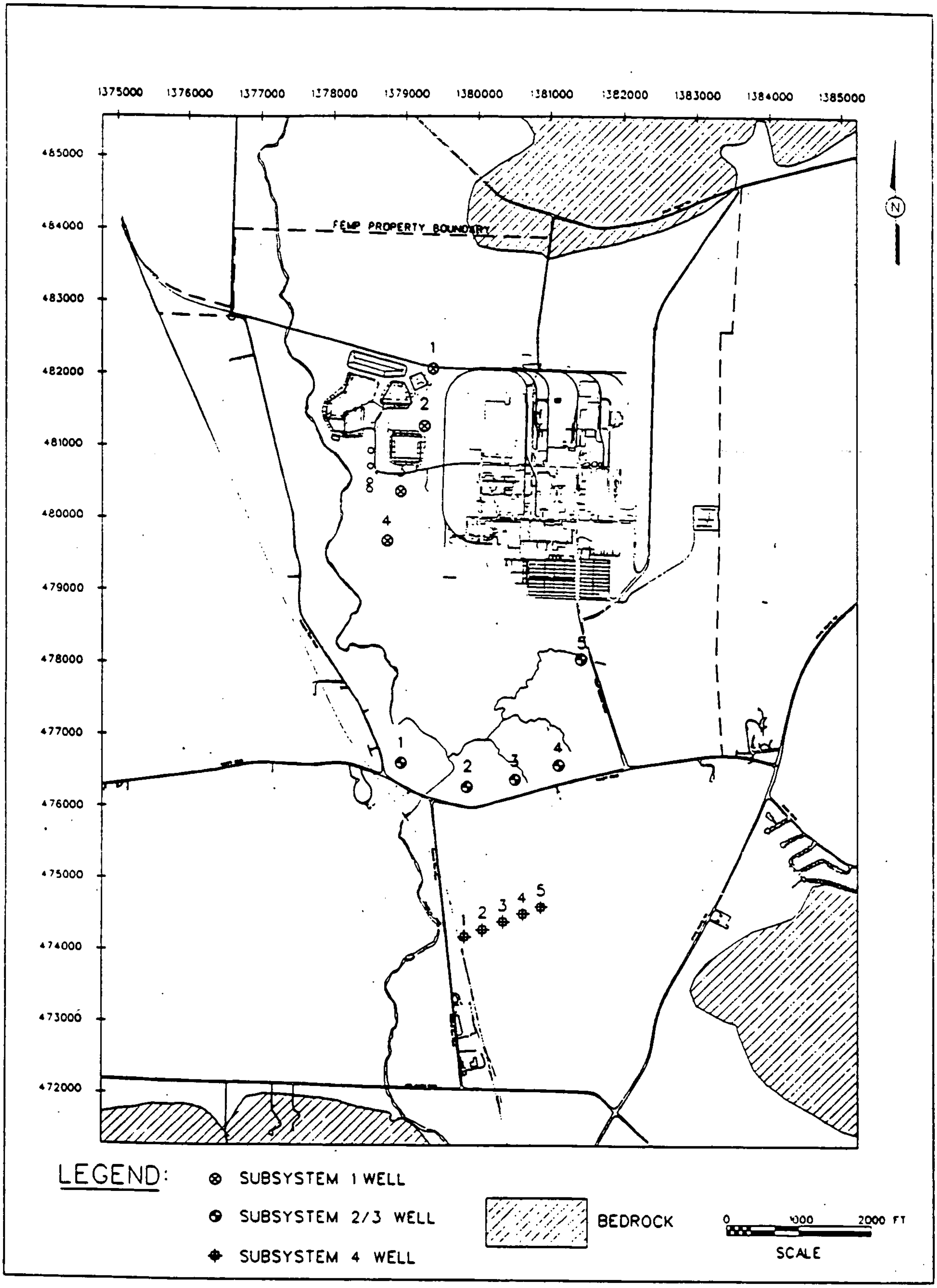


FIGURE 3-1. SCENARIO 1, WELL LOCATIONS

[redacted]

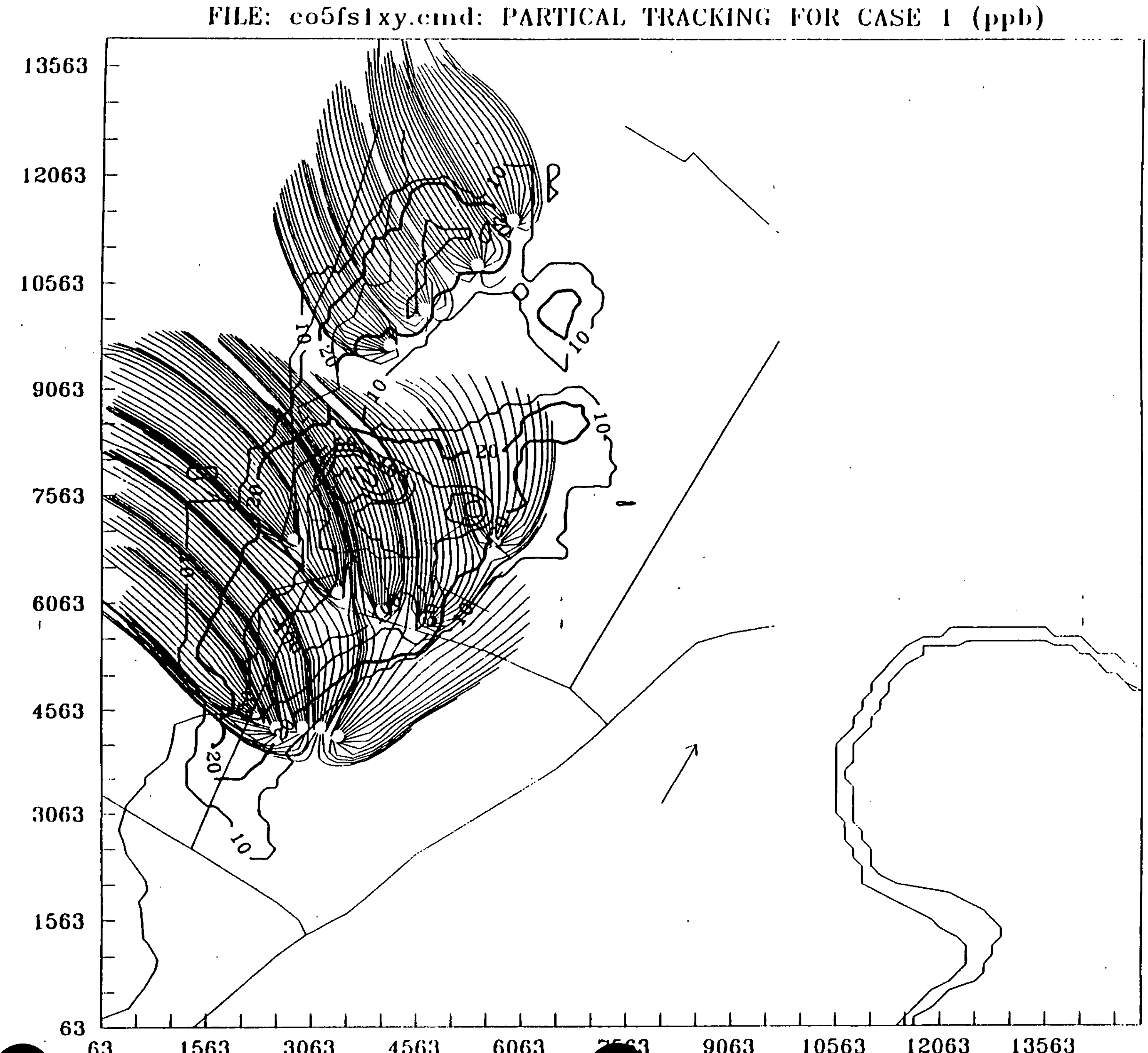


FIGURE 3-2. SCENARIO 1, 70-YEAR CAPTURE ZONE

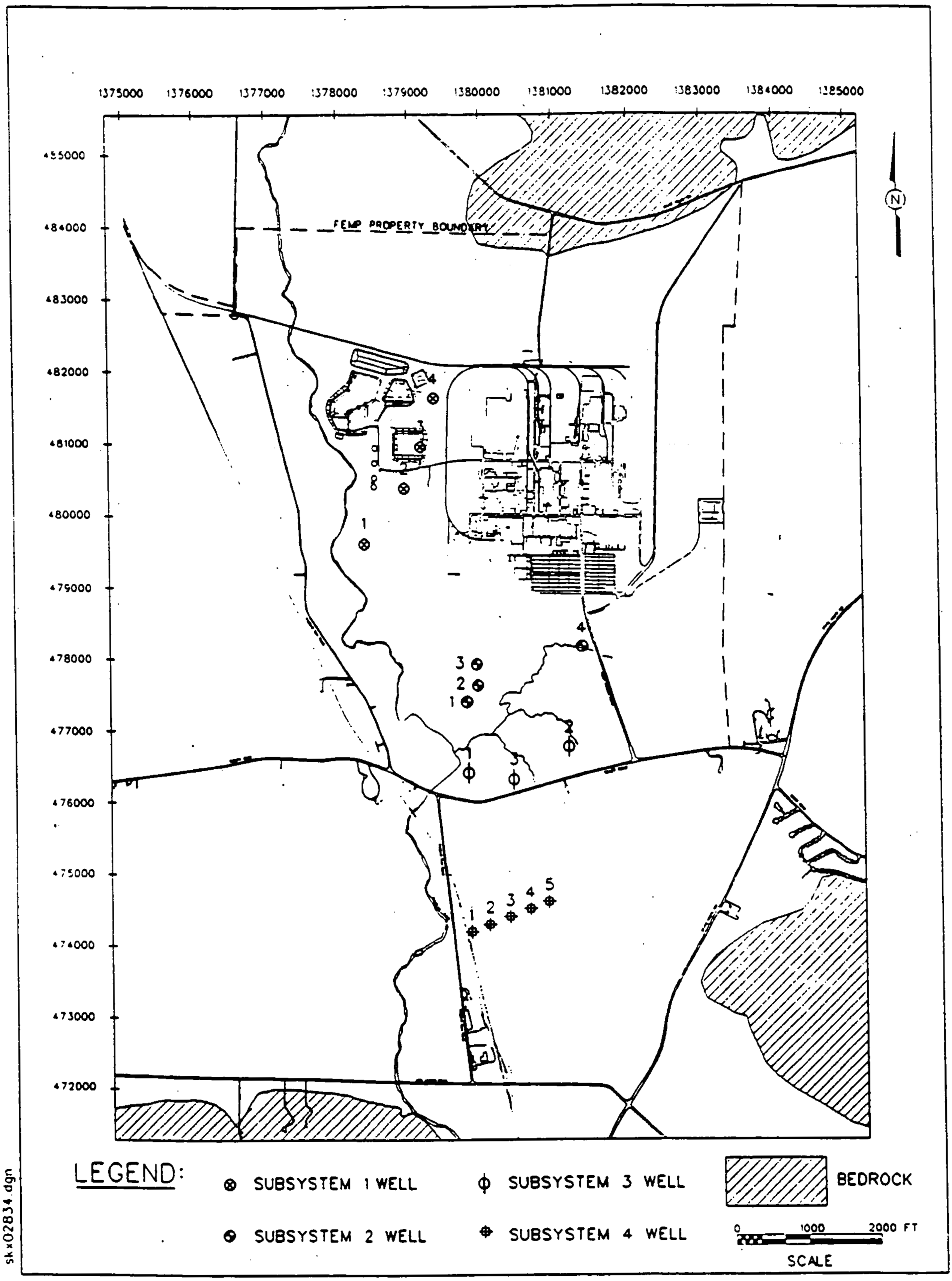


FIGURE 4a-1. SCENARIO 2, WELL LOCATIONS

FILE: co5fs4xy.cmd: PARTICAL TRACKING FOR CASE 4 (ppb)

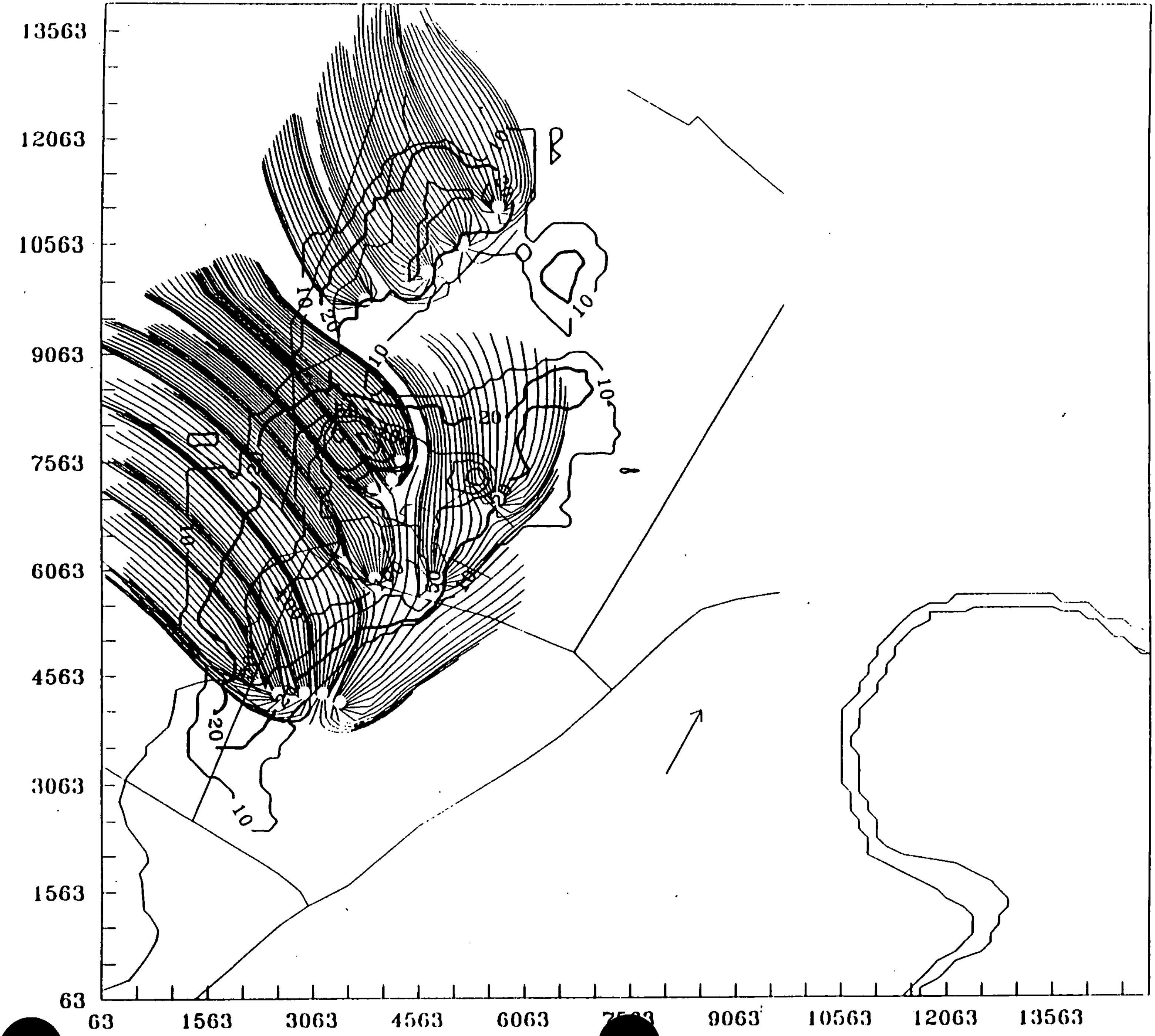


FIGURE 4a-2. SCENARIO 2, 70 YR. CAPTURE ZONE

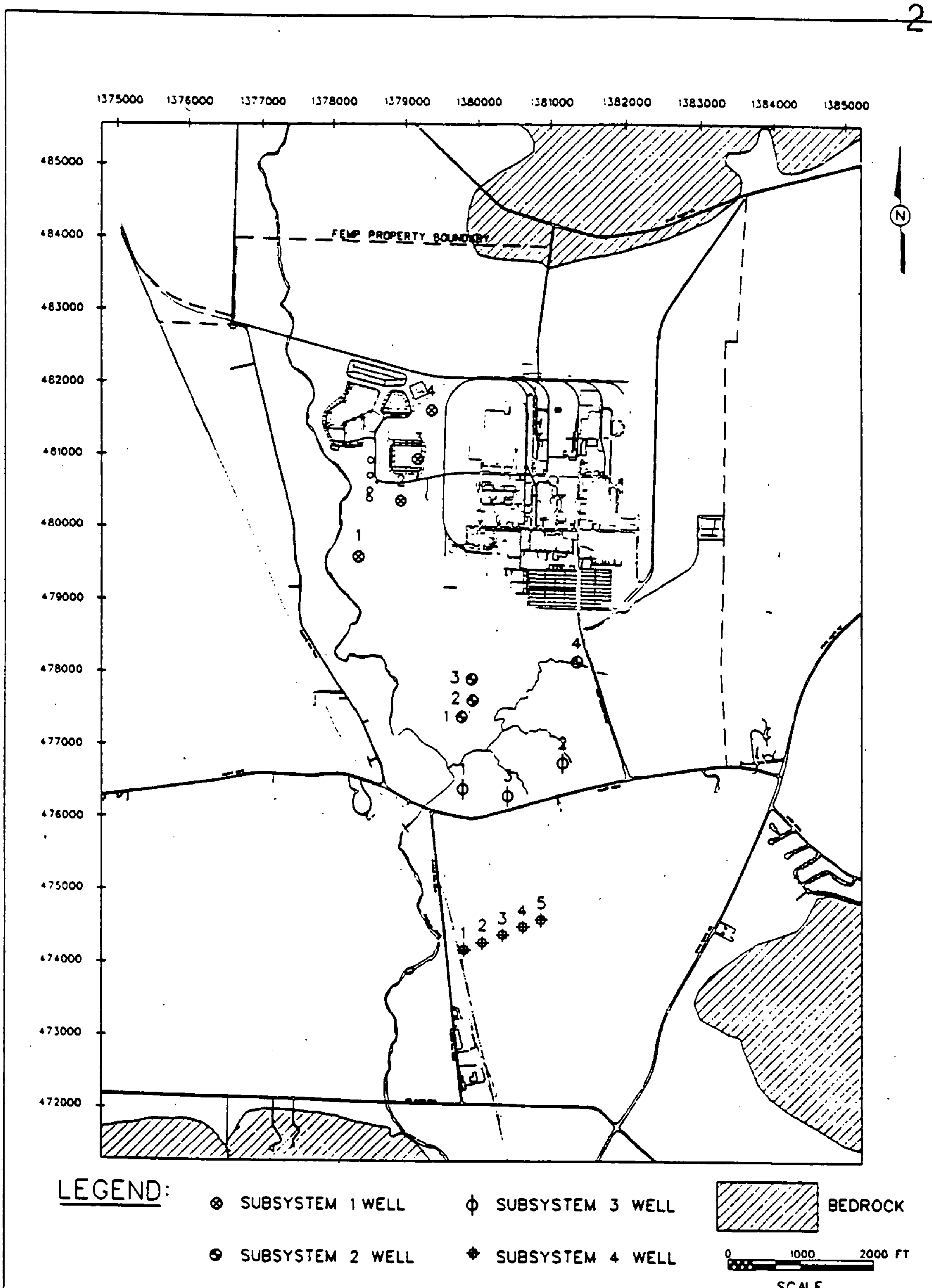


FIGURE 4b-1. SCENARIO 3, WELL LOCATIONS

FILE: co5fs5xy.cmd: PARTICAL TRACKING FOR CASE 5 (ppb)

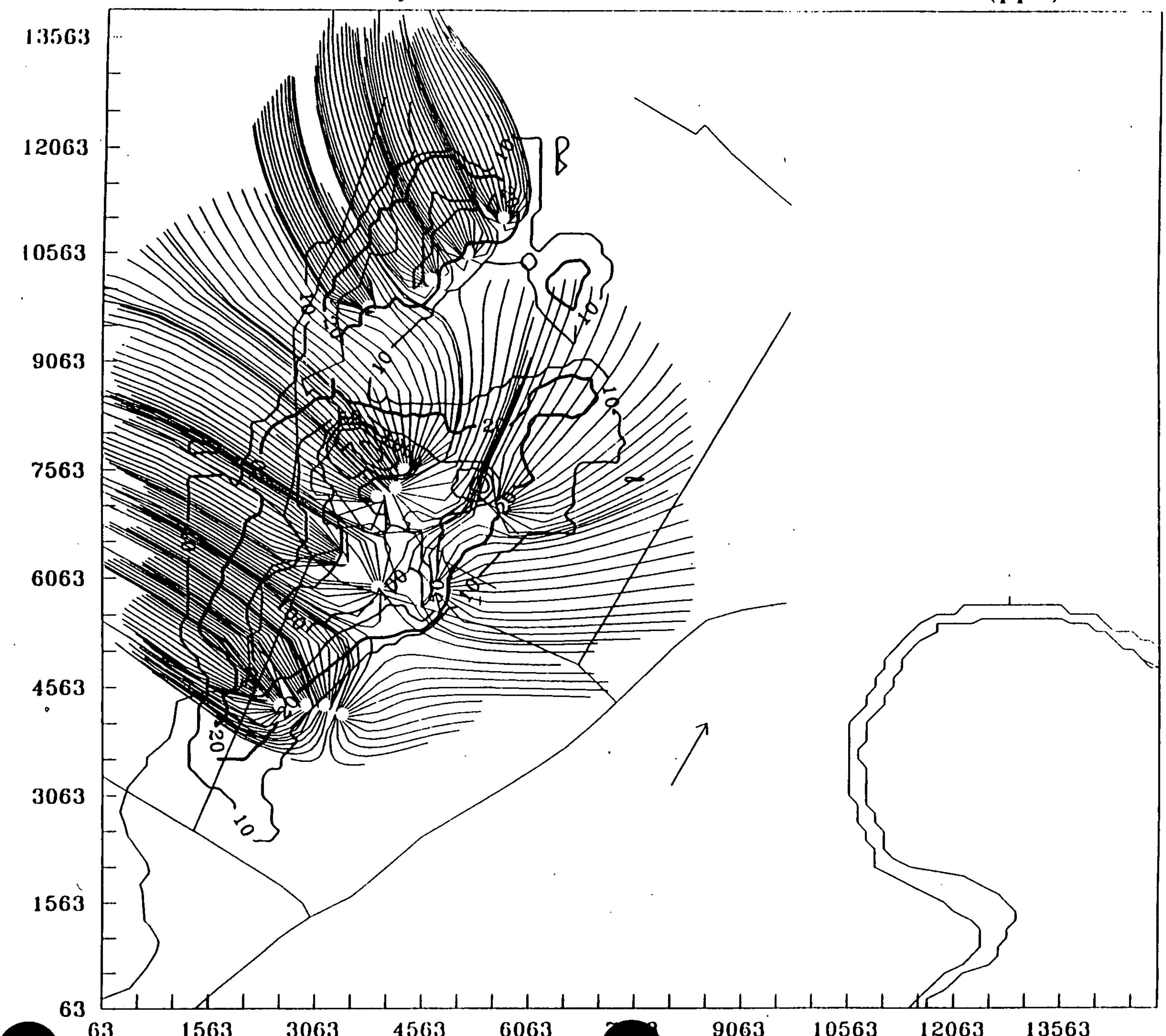


FIGURE 4b-2. SCENARIO 3, 70 YR. CAPTURE ZONE

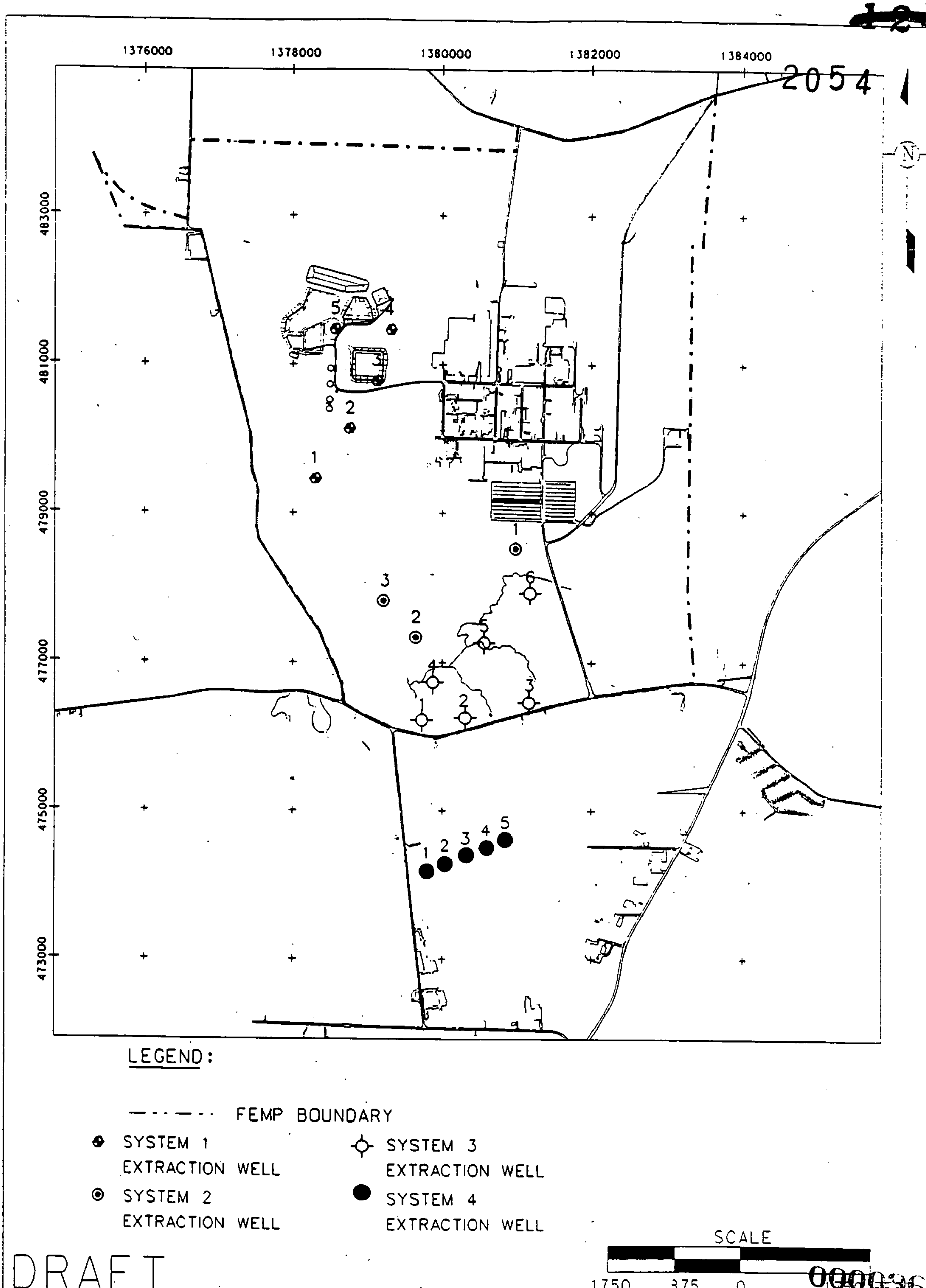


FIGURE 5-1. SCENARIO 1, WELL LOCATIONS

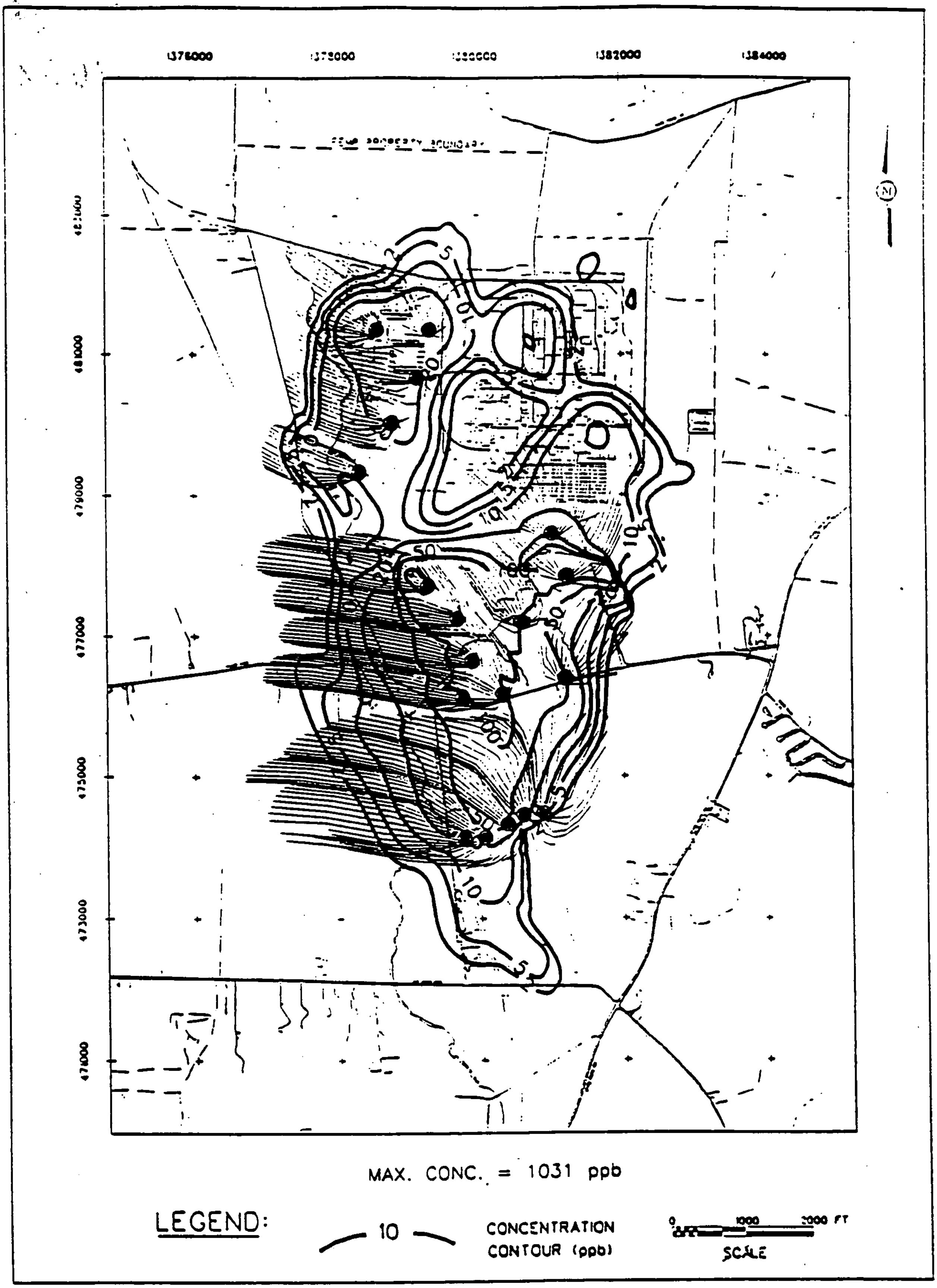


FIGURE 5-2: EXTRACTION SCENARIO 1-CAPTURE ZONE 35 YRS.

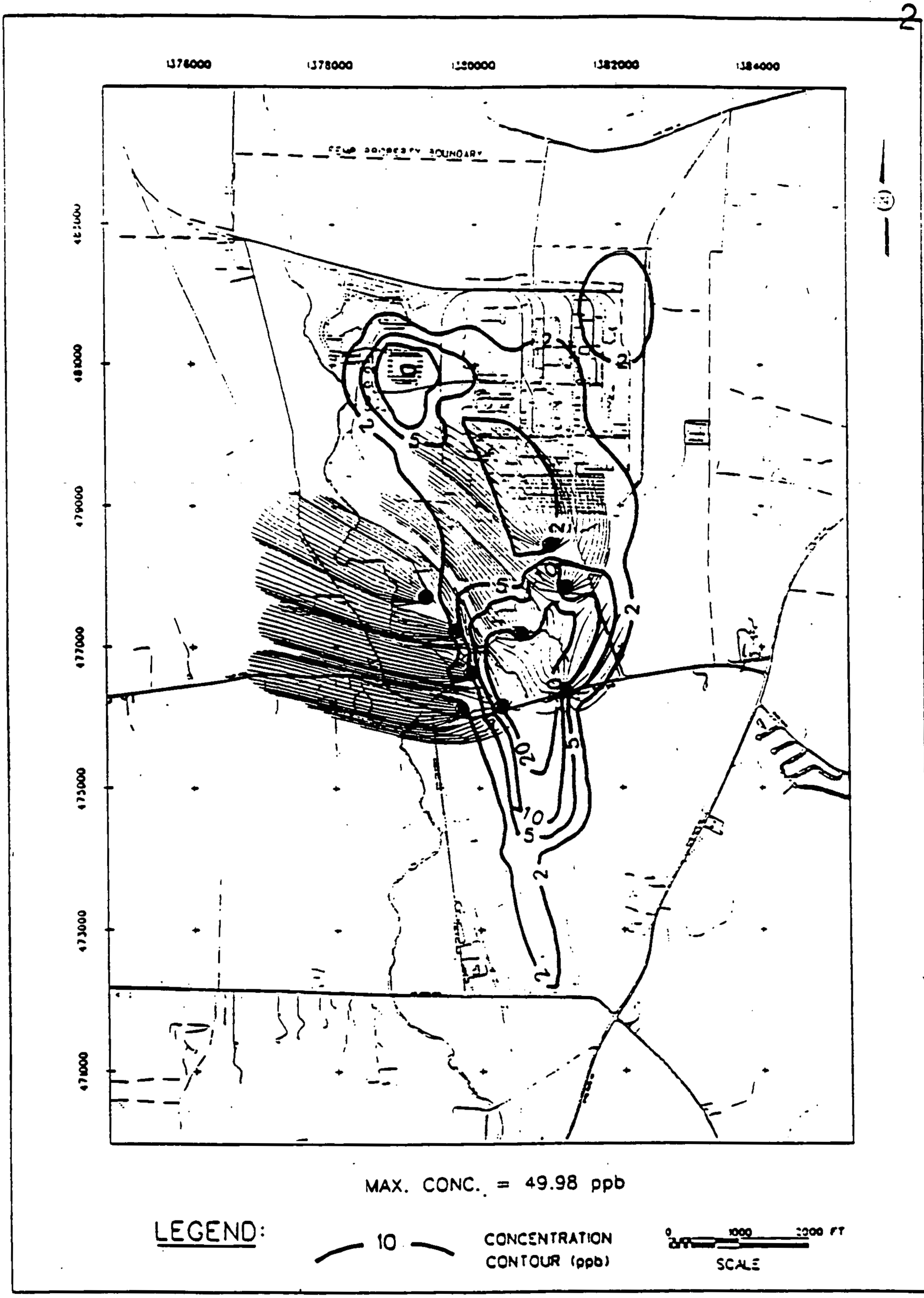


FIGURE 5-3. EXTRACTION SCENARIO 1-CAPTURE ZONE 75 YRS.

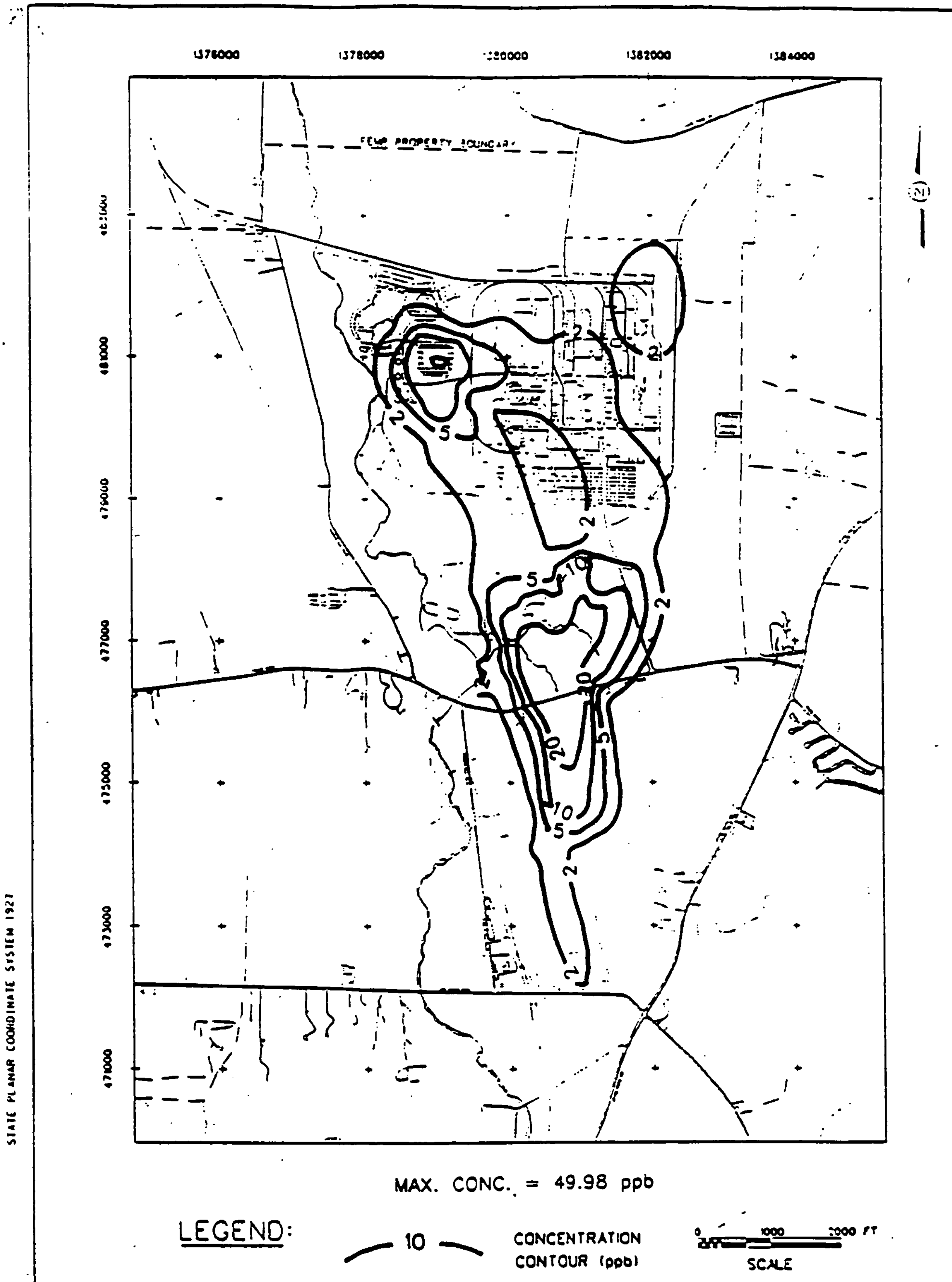


FIGURE 5-4. EXTRACTION SCENARIO 1 - CONCENTRATION CONTOURS 35 YEARS, LAYER 1

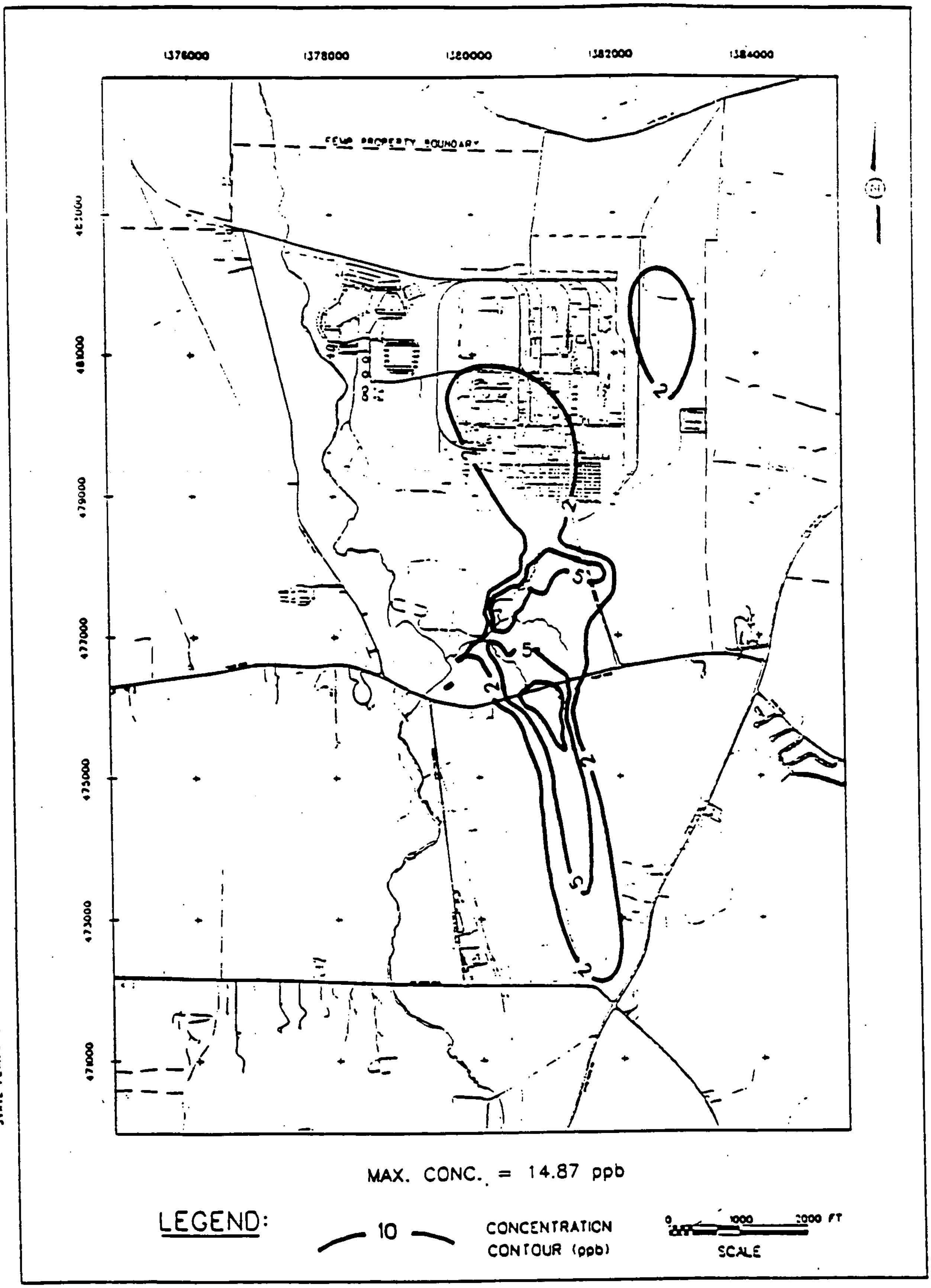


FIGURE 5-5. EXTRACTION SCENARIO 1 - CONCENTRATION CONTOURS
75 YEARS, LAYER 1

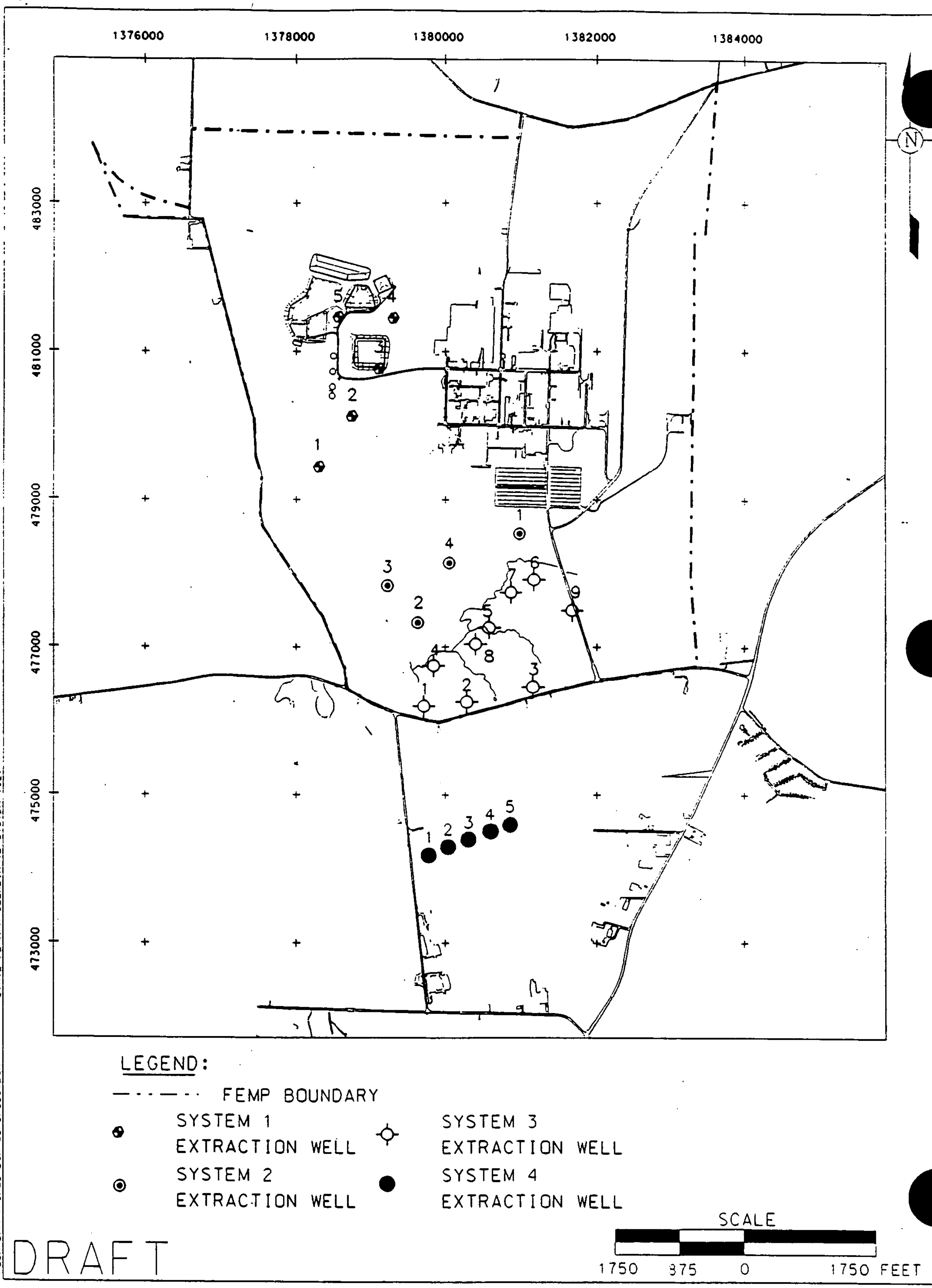


FIGURE 6-1. SCENARIO 2. WELL LOCATIONS

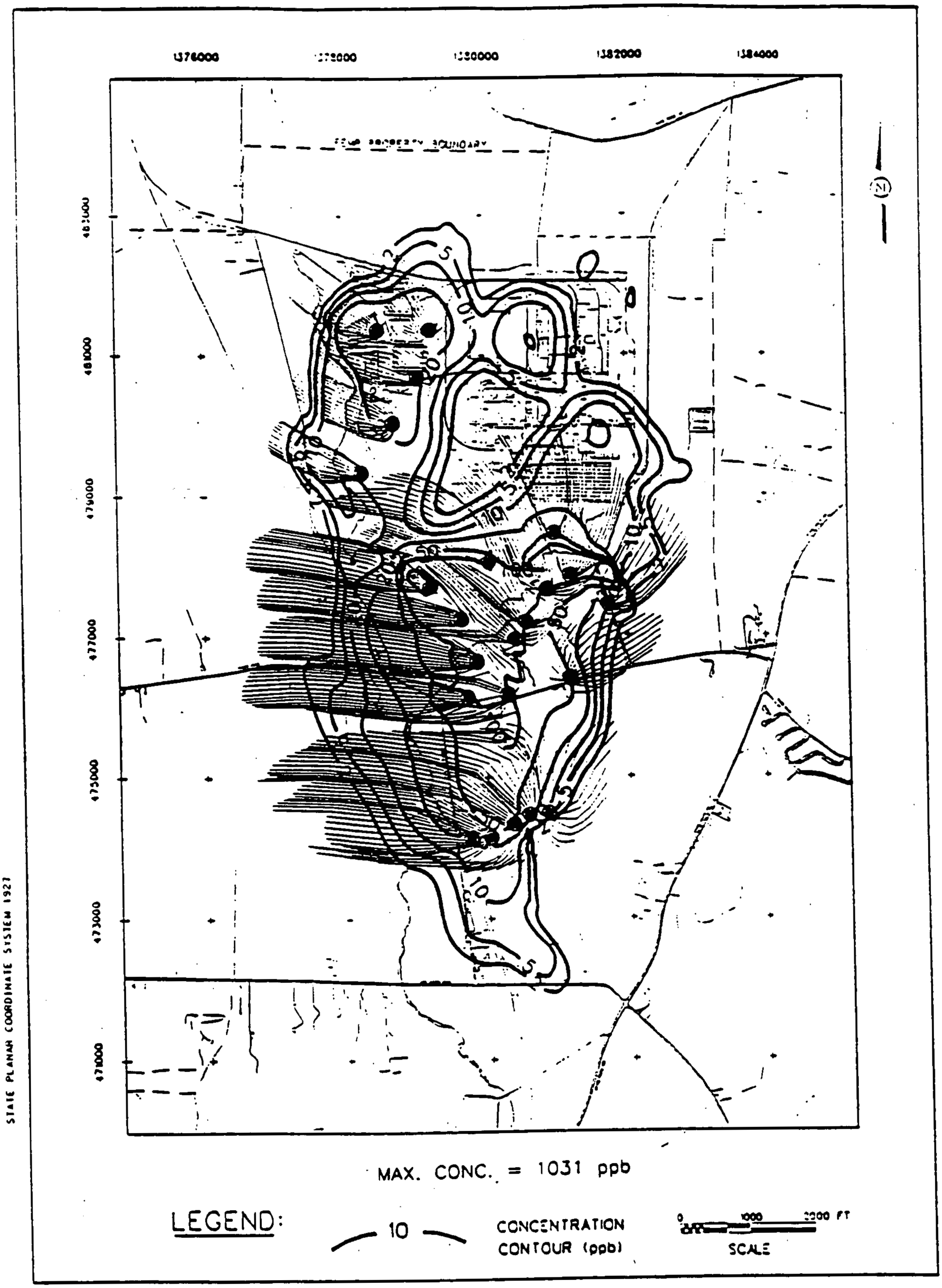


FIGURE 6-2. EXTRACTION SCENARIO 2, CAPTURE ZONE 35 YRS.

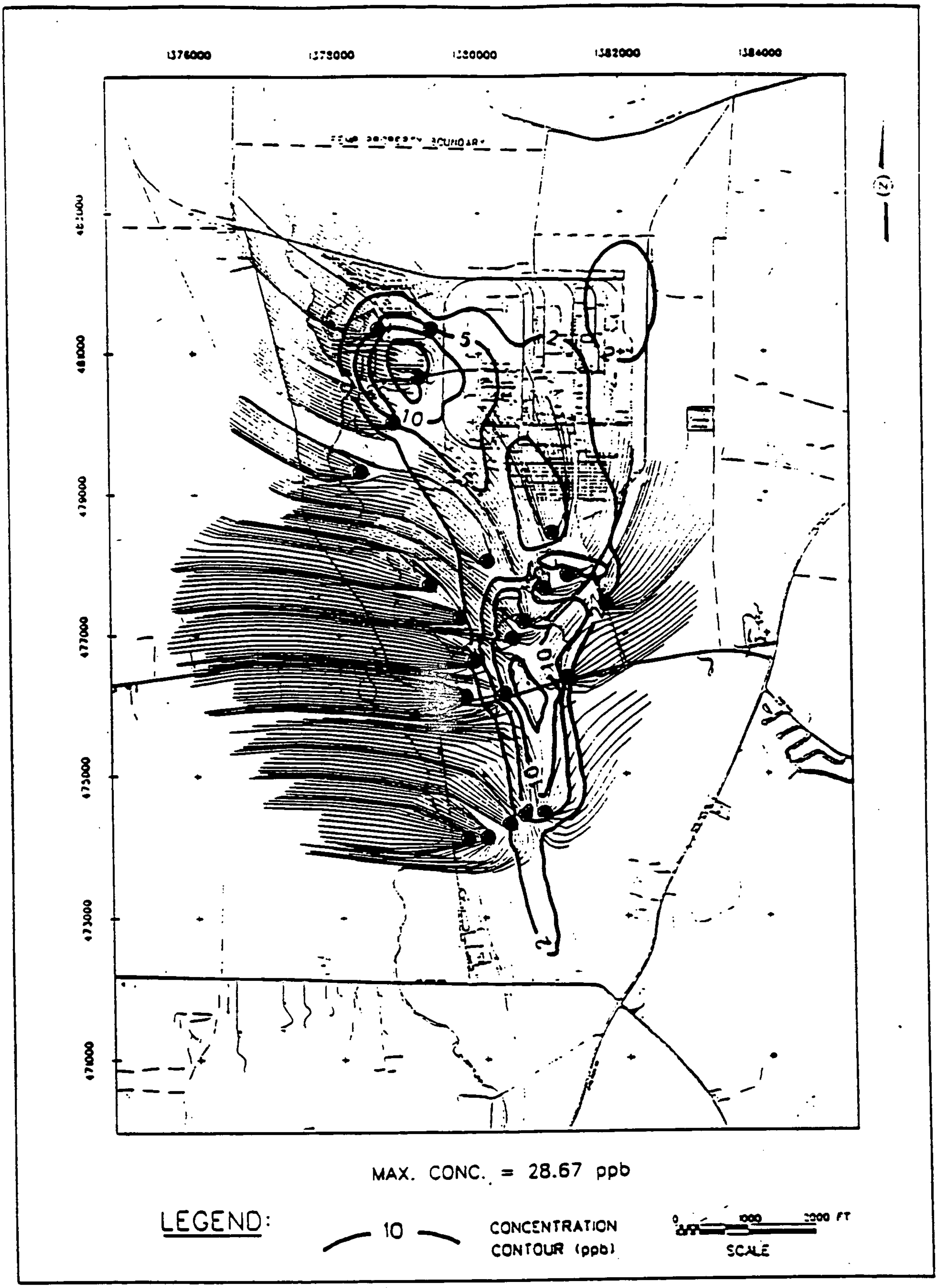


FIGURE 6-3. EXTRACTION SCENARIO 2, CAPTURE ZONE 75 YRS.

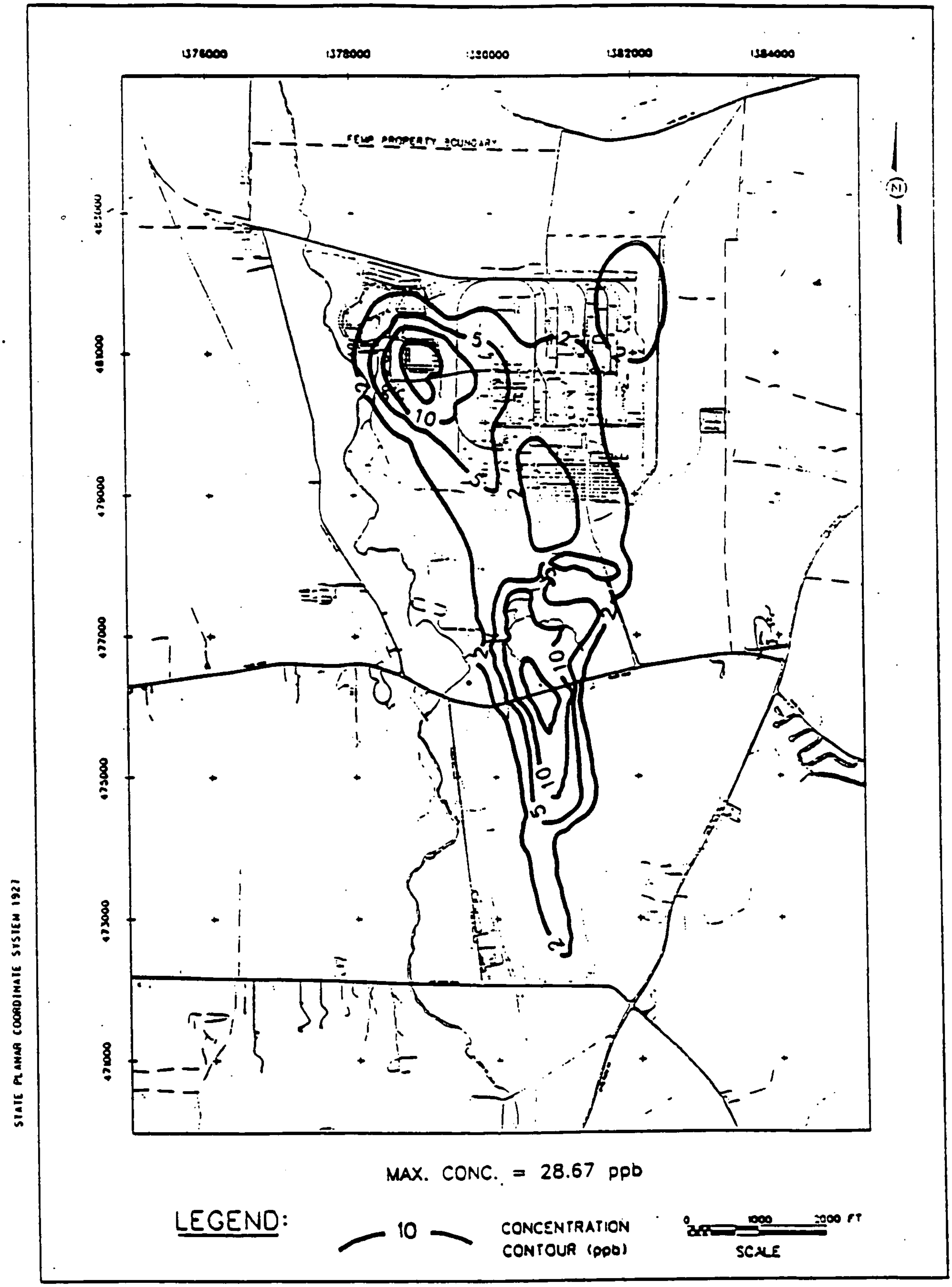


FIGURE 6-4. EXTRACTION SCENARIO 2 - CONCENTRATION CONTOURS
35 YEARS, LAYER 1

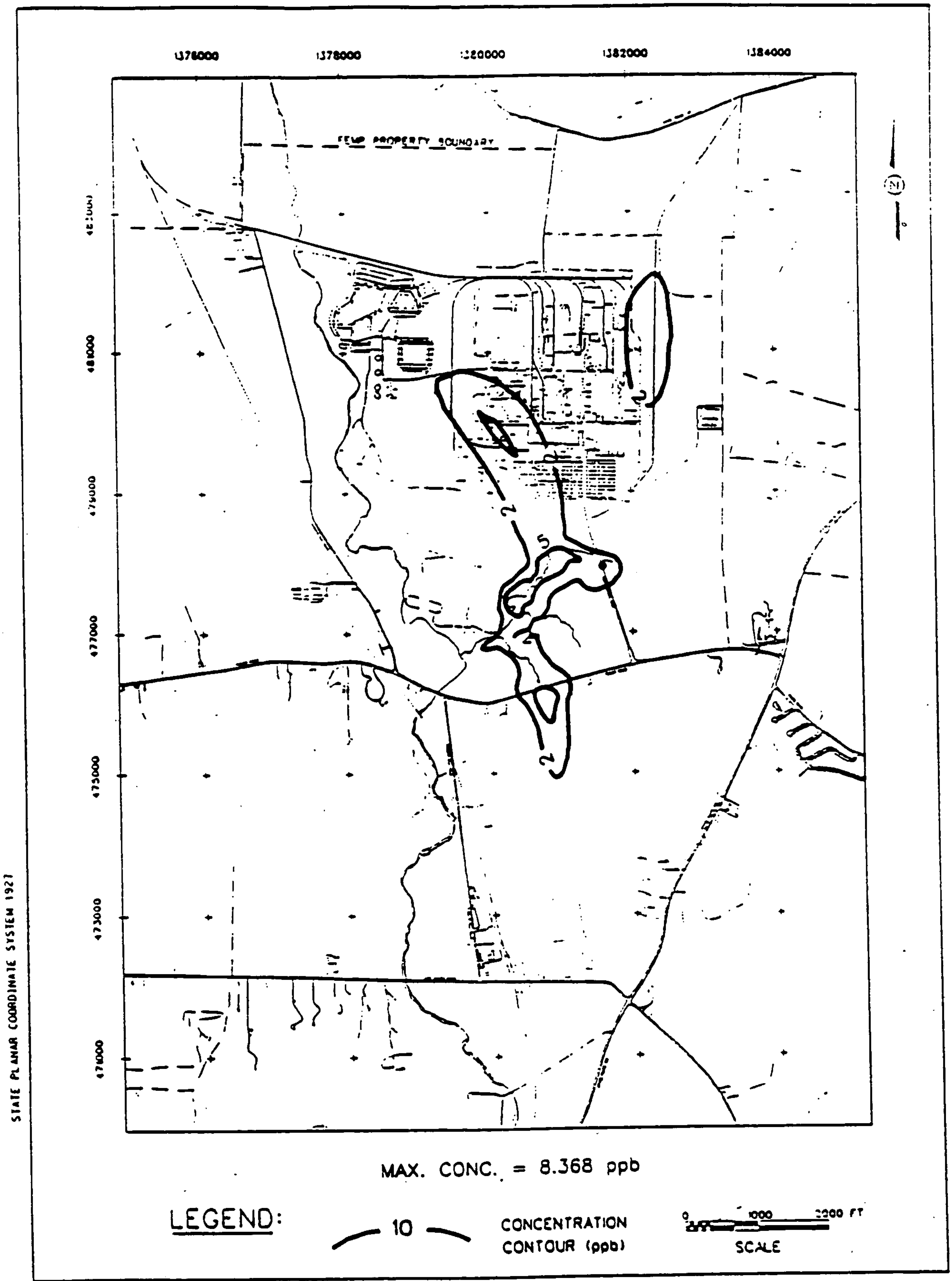


FIGURE 6-5. EXTRACTION SCENARIO 2 - CONCENTRATION CONTOURS
75 YEARS, LAYER 1

2054

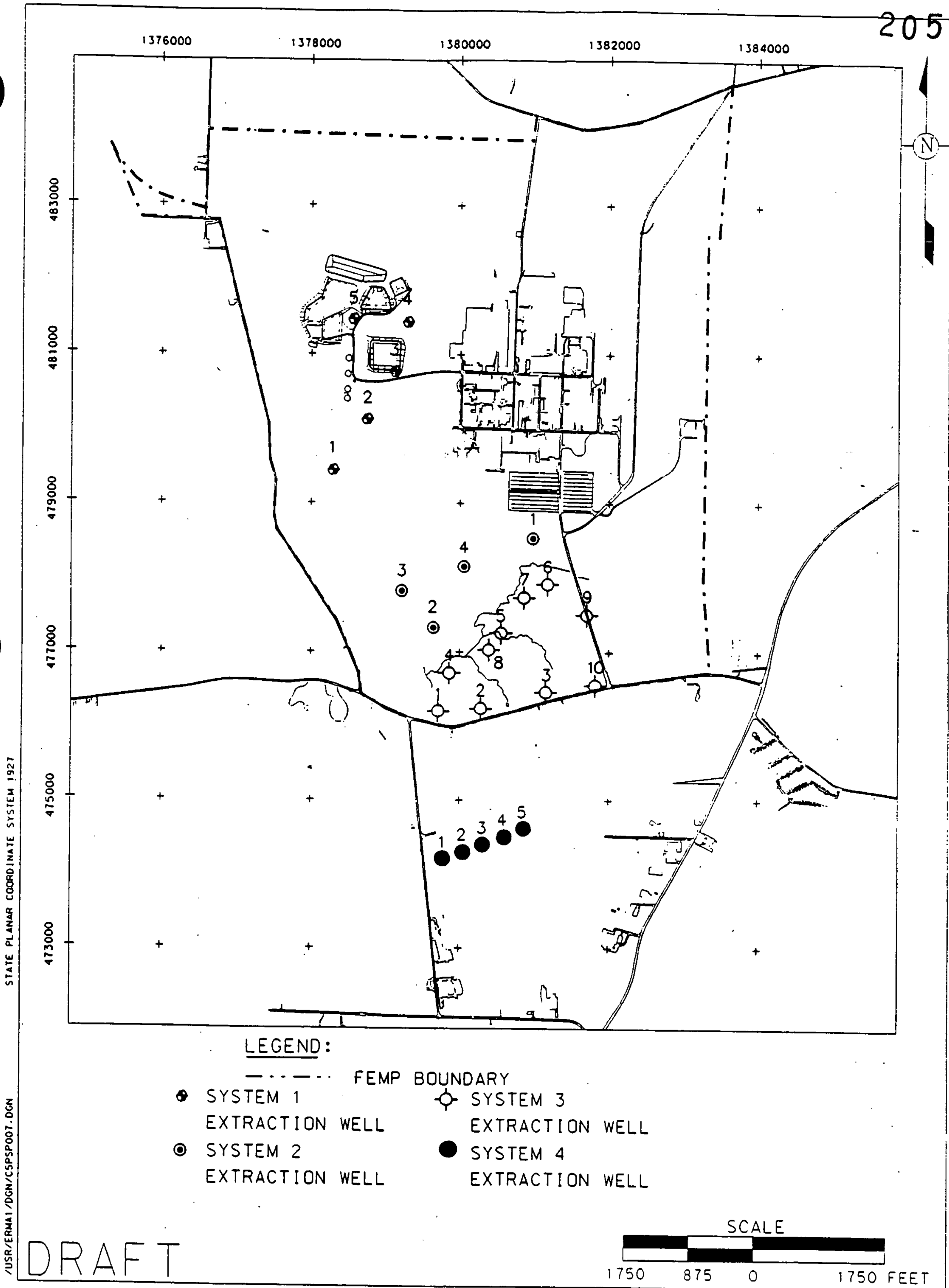


FIGURE 7-1. SCENARIO 3. WELL LOCATIONS

000106

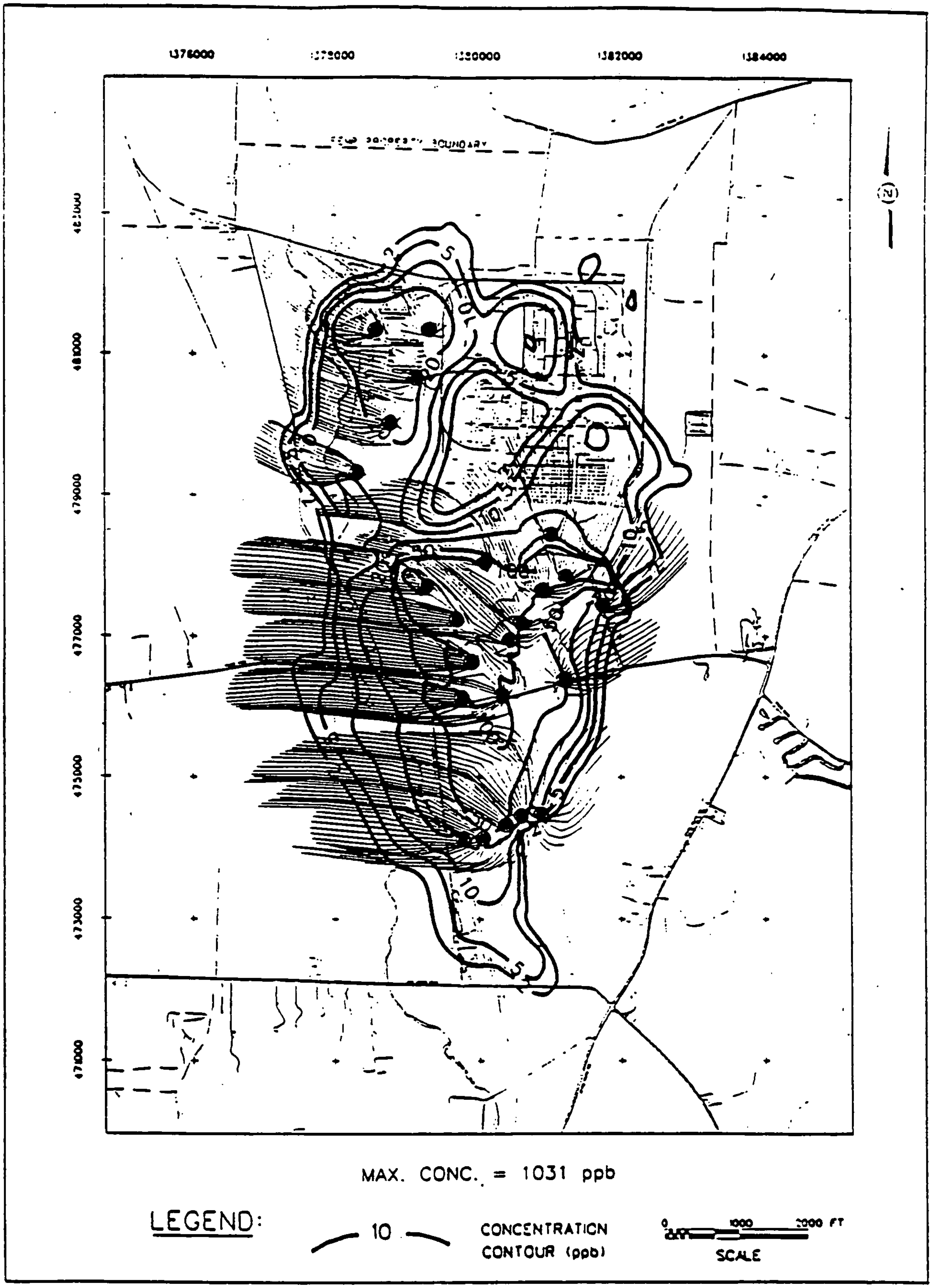


FIGURE 7-2. EXTRACTION SCENARIO 3, CAPTURE ZONE 35 YRS.

2054

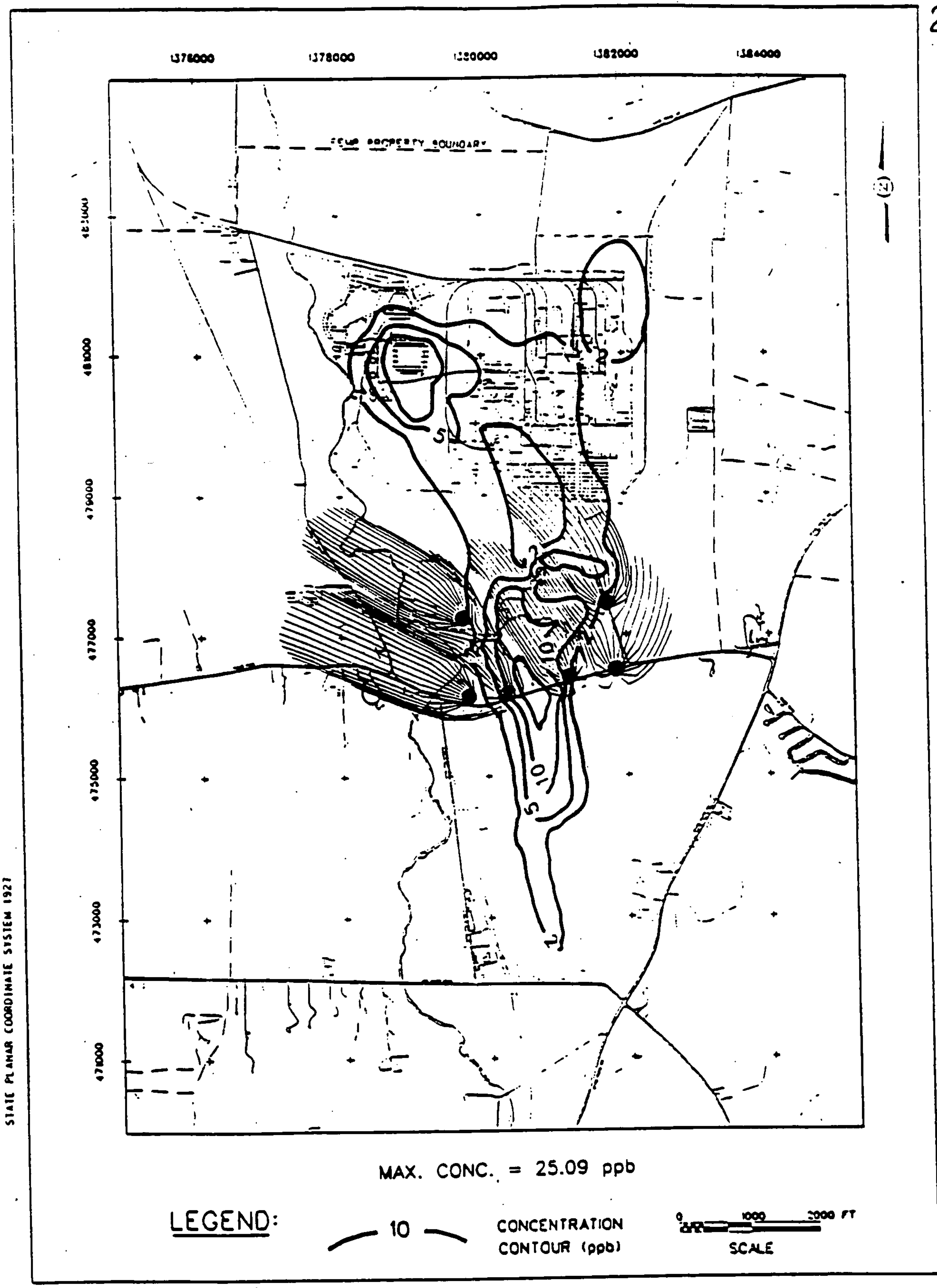


FIGURE 7-3. EXTRACTION SCENARIO 3, CAPTURE ZONE 75 YRS.

000108

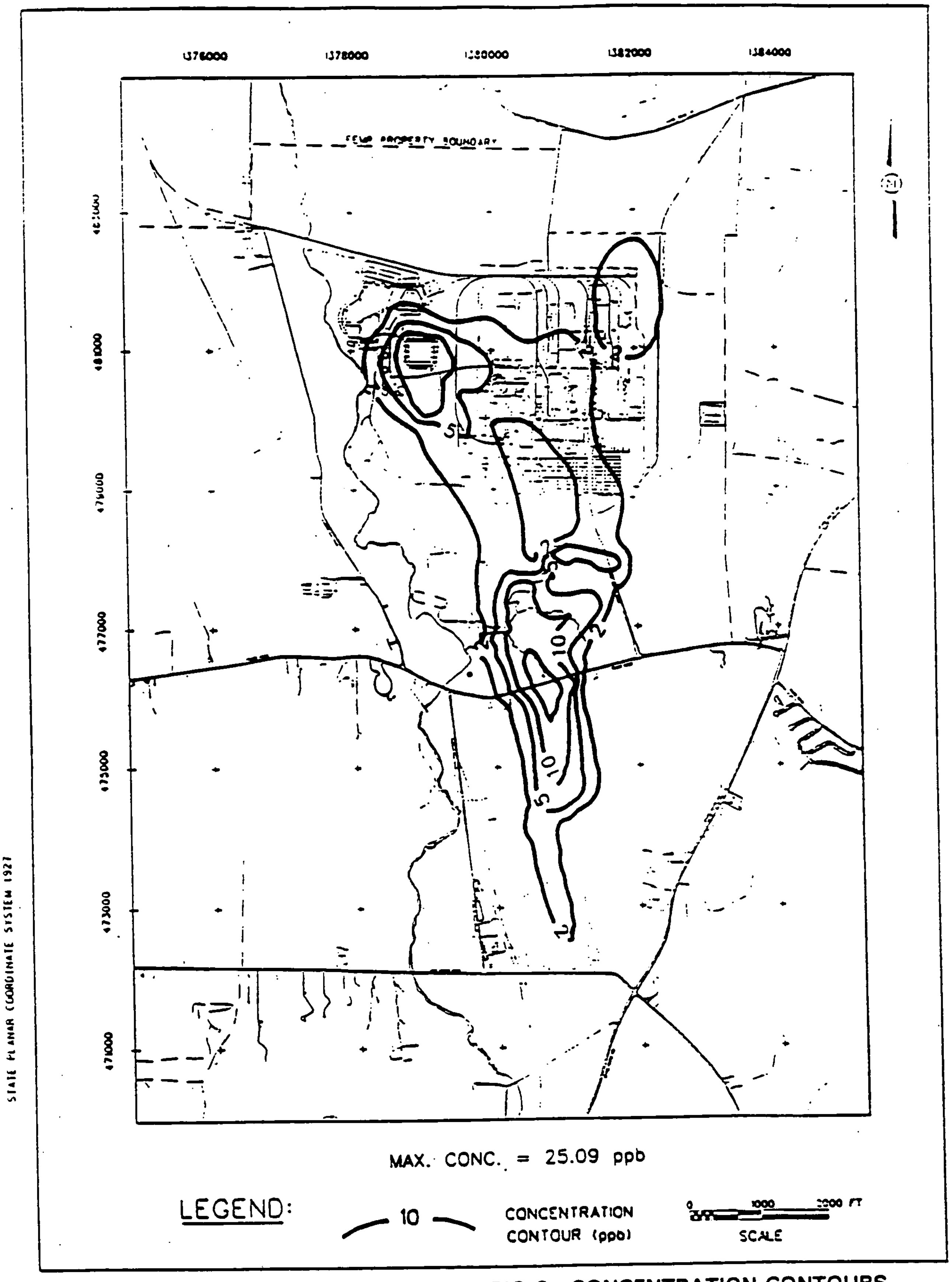


FIGURE 7-4. EXTRACTION SCENARIO 3 - CONCENTRATION CONTOURS 35 YEARS, LAYER 1

000109

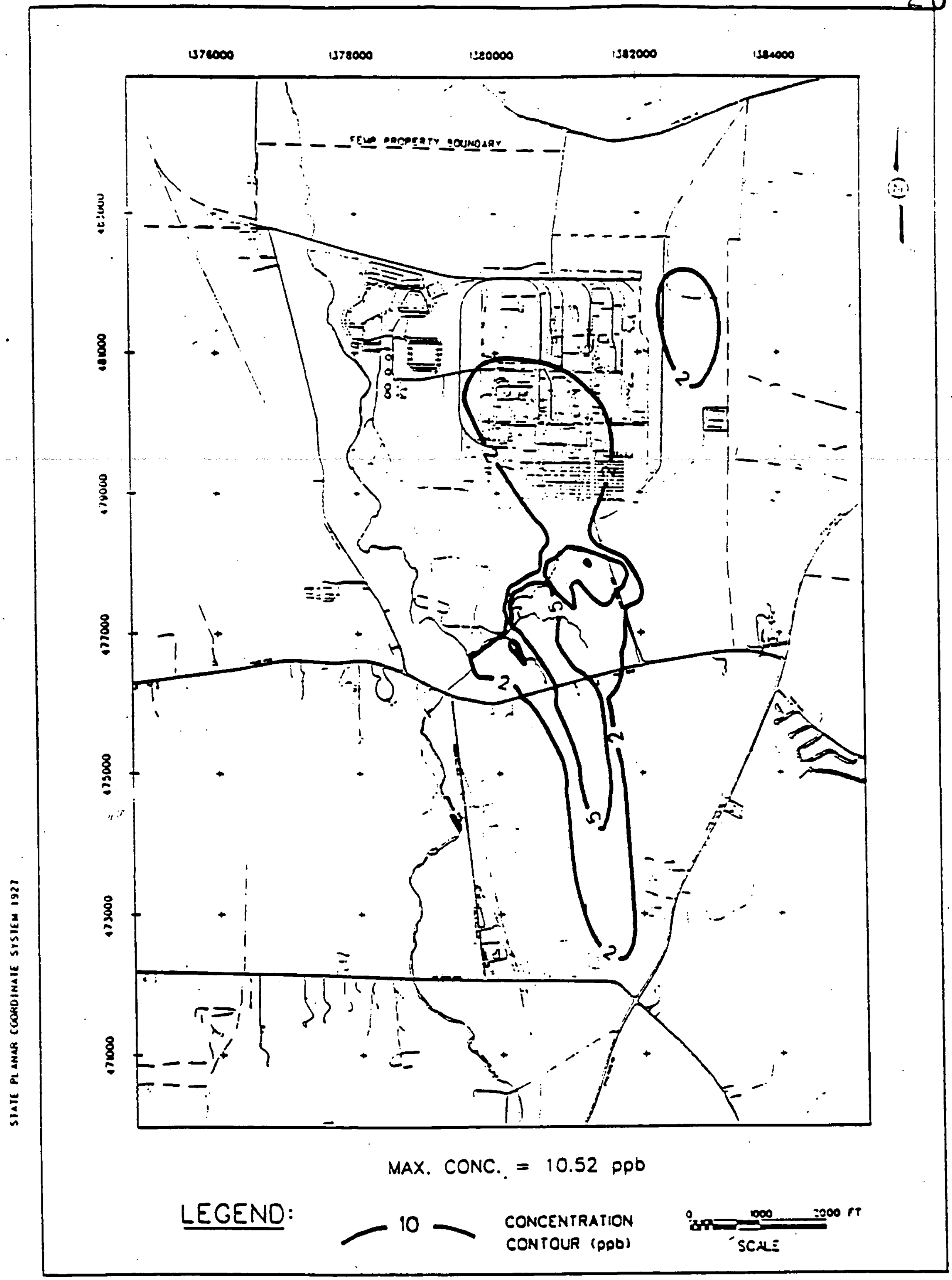


FIGURE 7-5. EXTRACTION SCENARIO 3 - CONCENTRATION CONTOURS
75 YEARS, LAYER 1

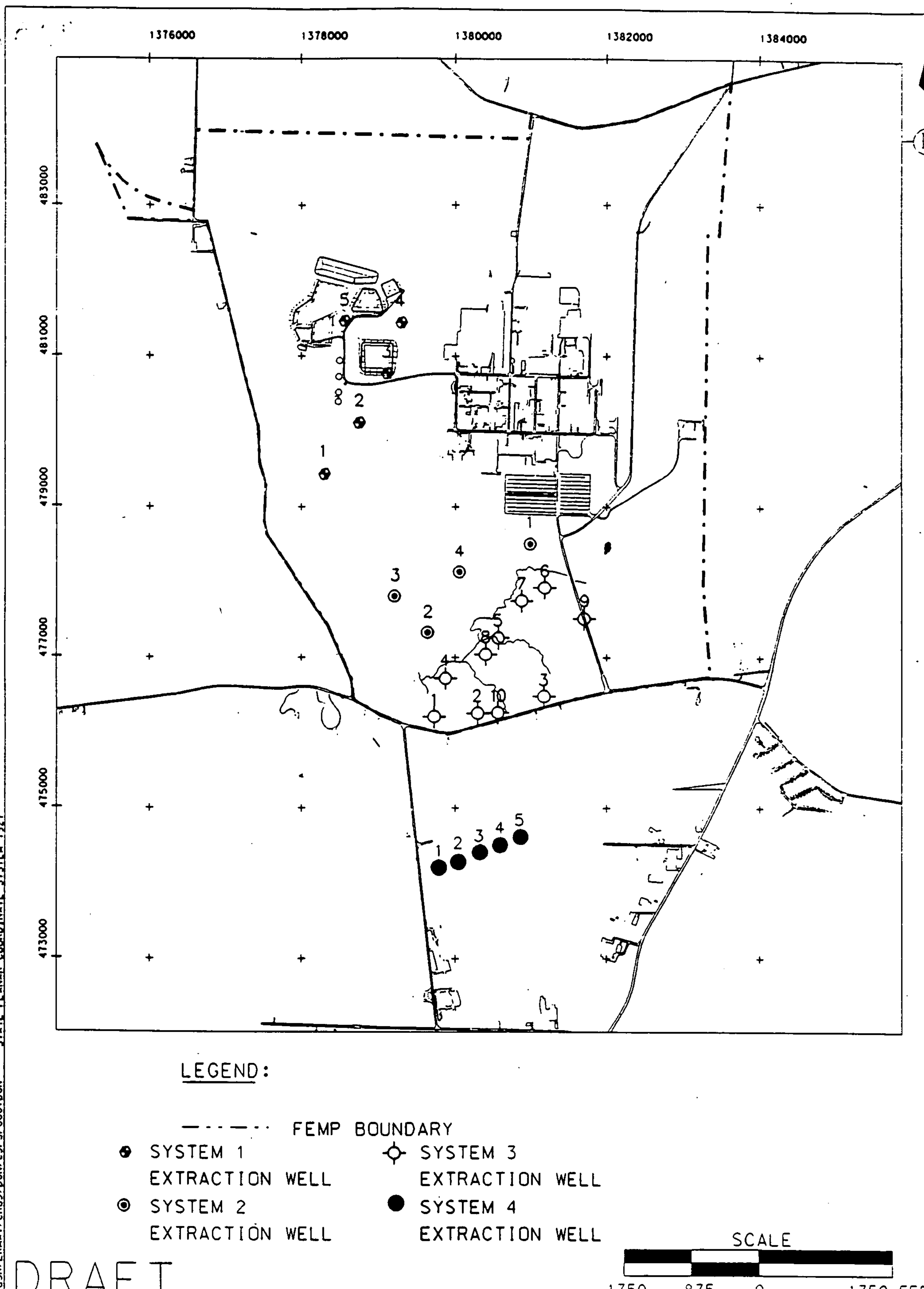


FIGURE 8-1. SCENARIO 4. WELL LOCATIONS

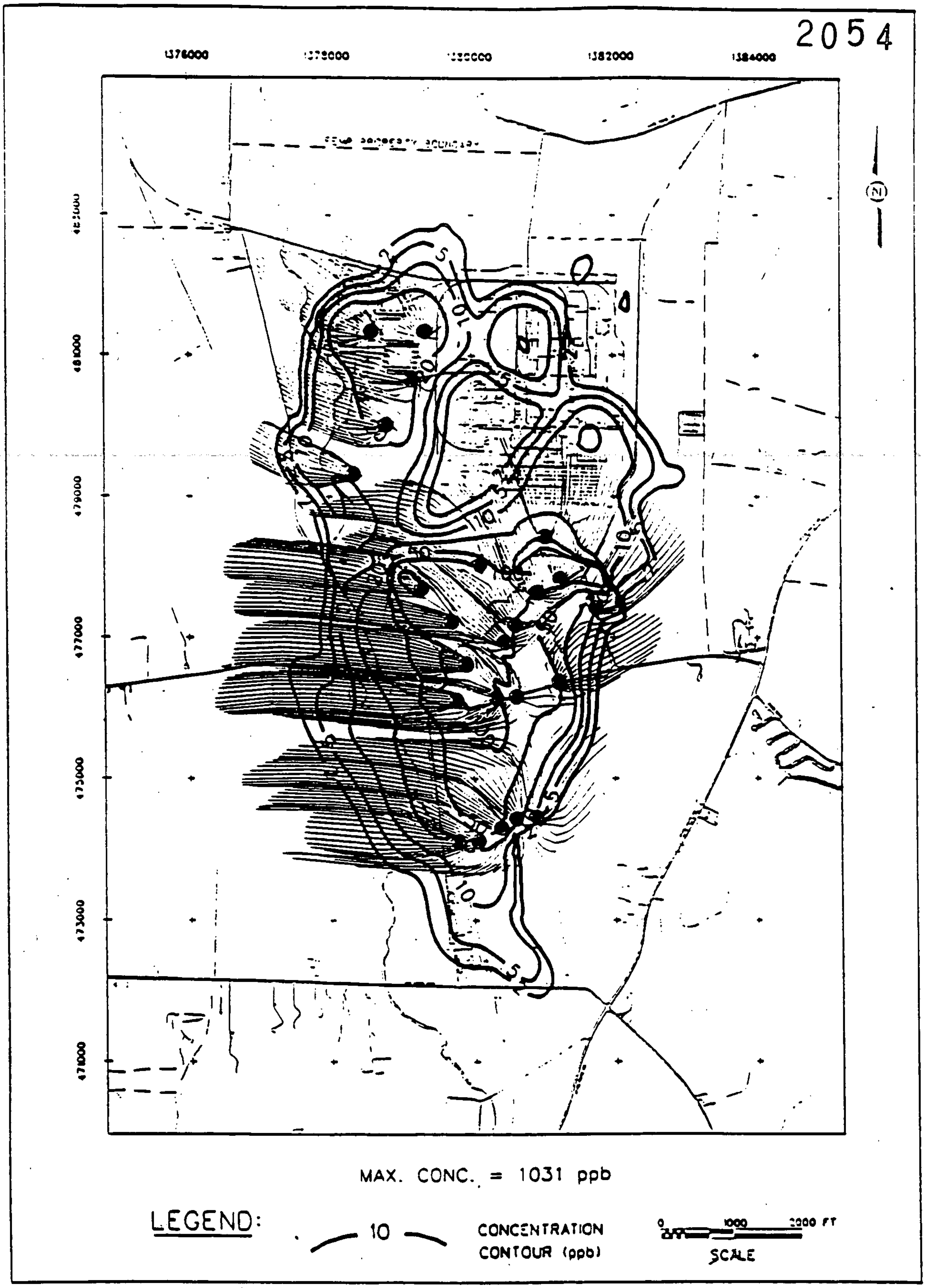


FIGURE 8-2. EXTRACTION SCENARIO 4, CAPTURE ZONE 35 YRS.

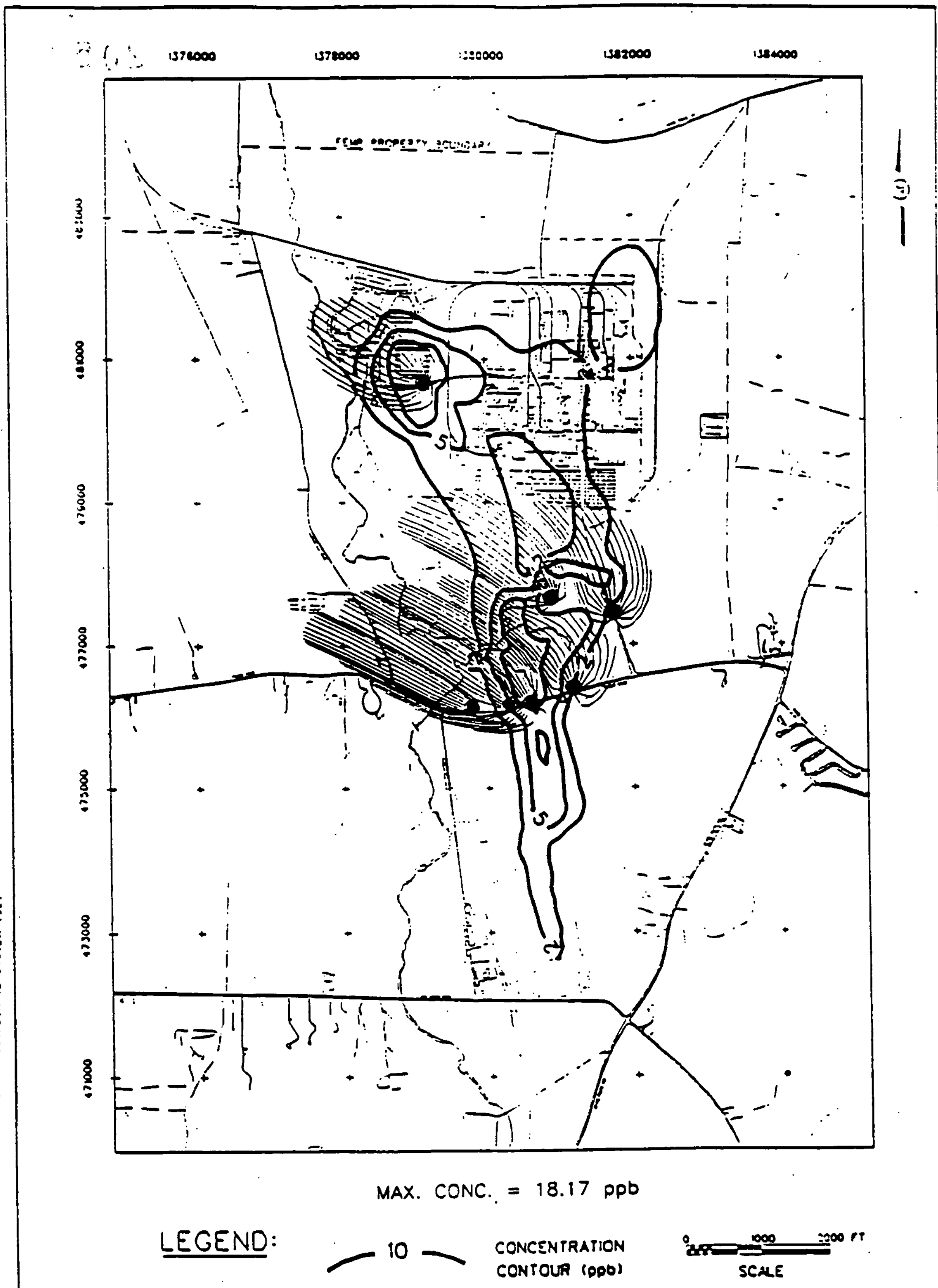


FIGURE 8-3. EXTRACTION SCENARIO 4, CAPTURE ZONE 75 YRS.

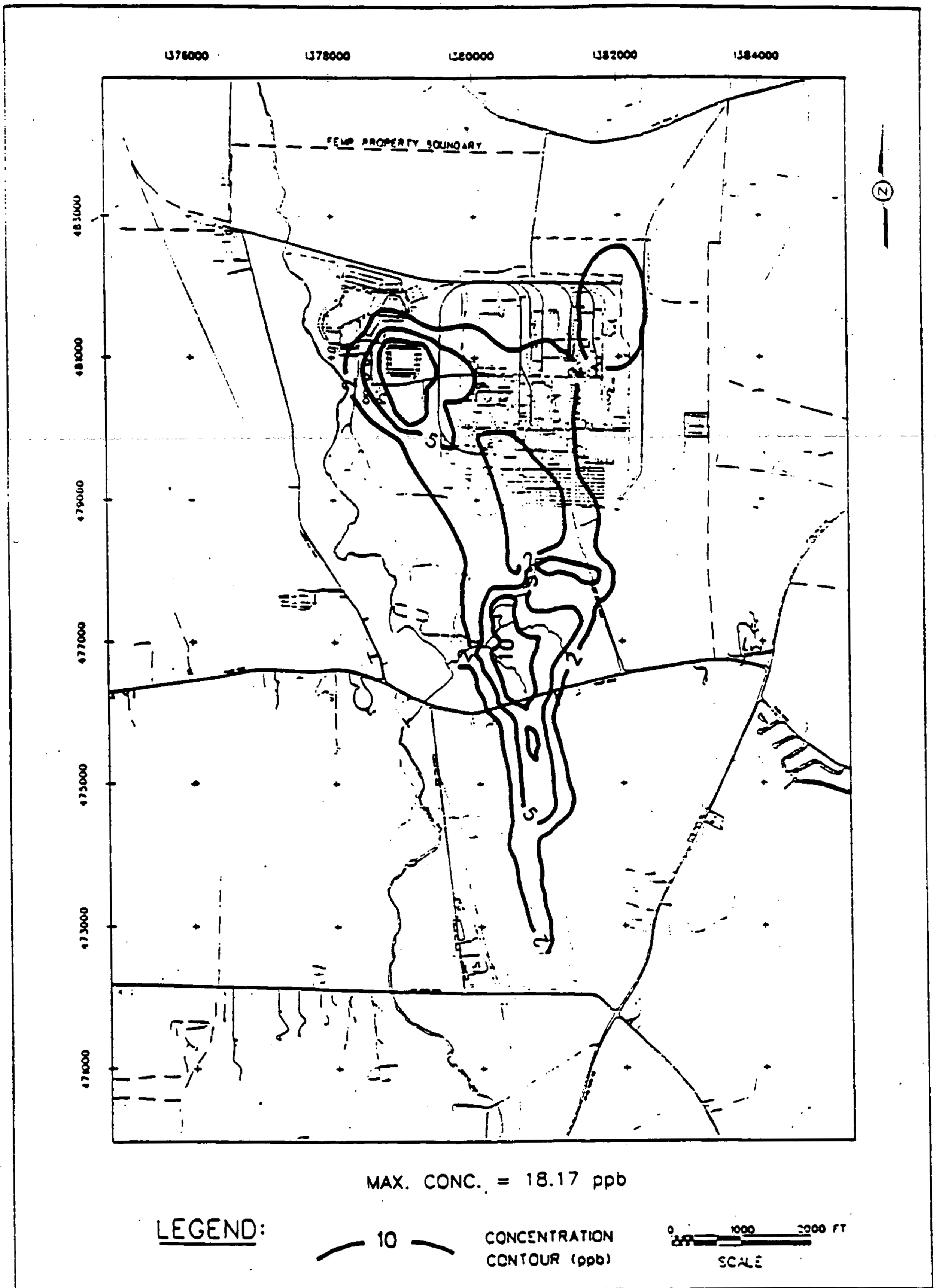


FIGURE 8-4. EXTRACTION SCENARIO 4 - CONCENTRATION CONTOURS
35 YEARS, LAYER 1

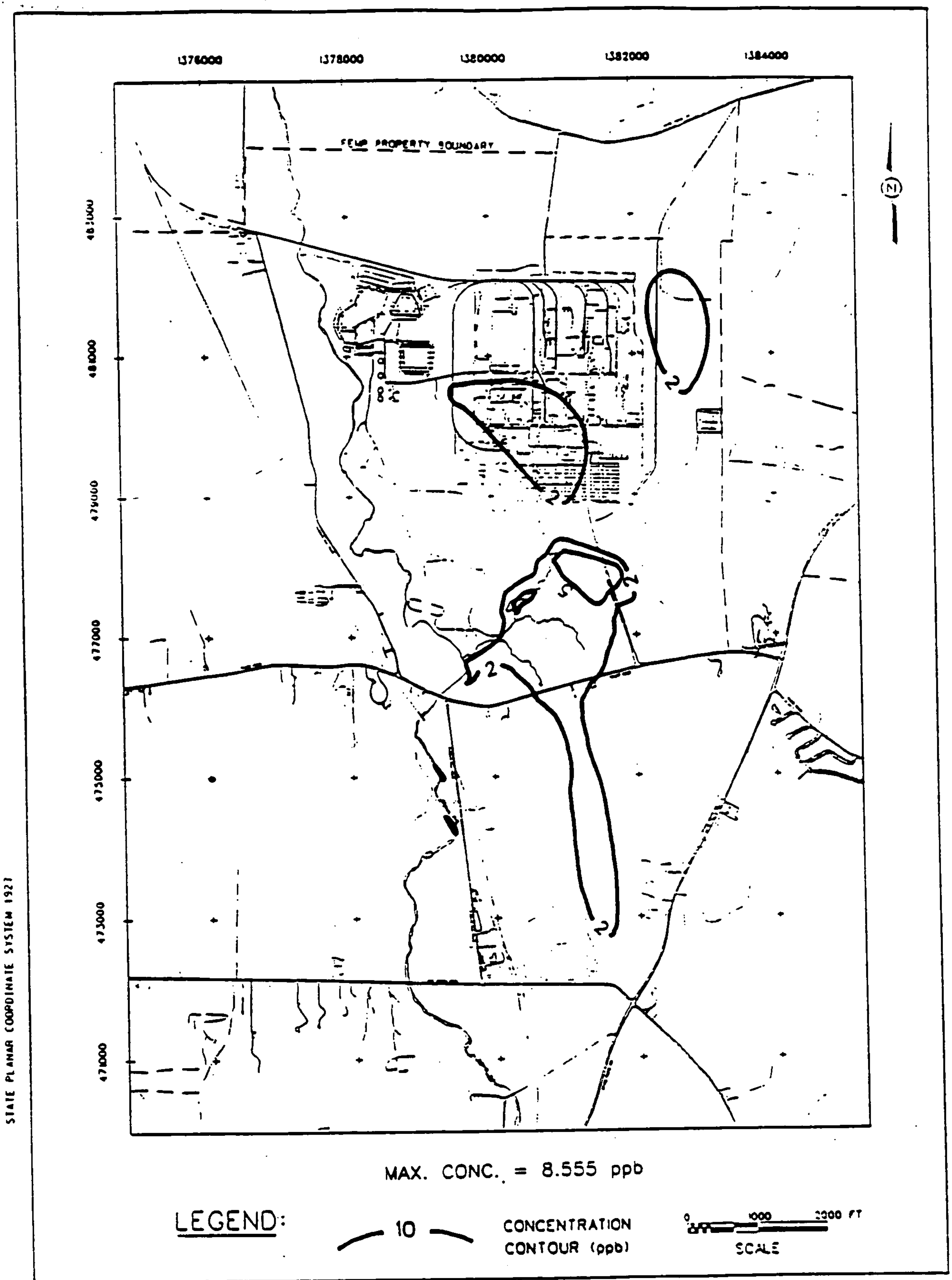


FIGURE 8-5. EXTRACTION SCENARIO 4 - CONCENTRATION CONTOURS 75 YEARS, LAYER 1

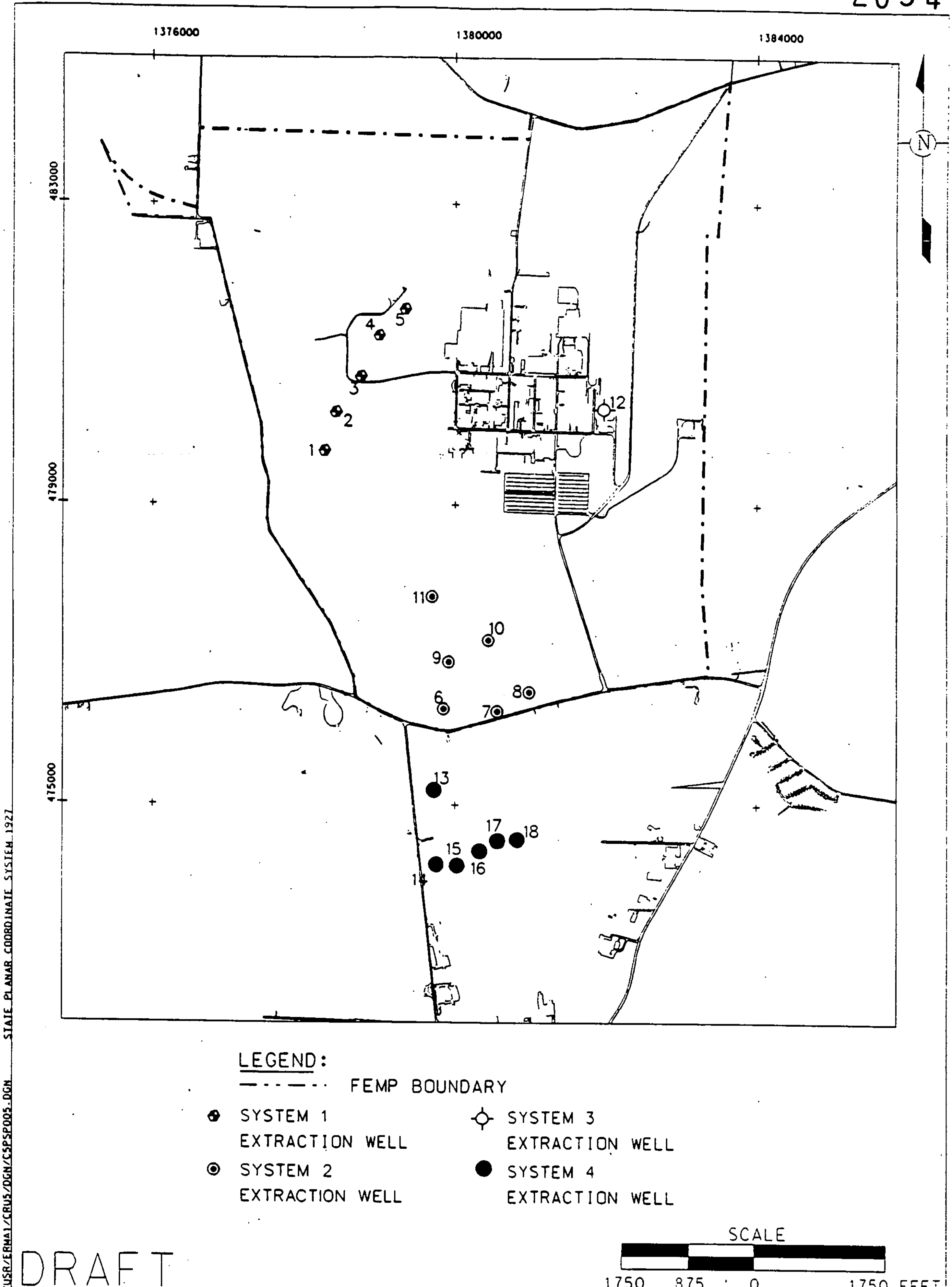
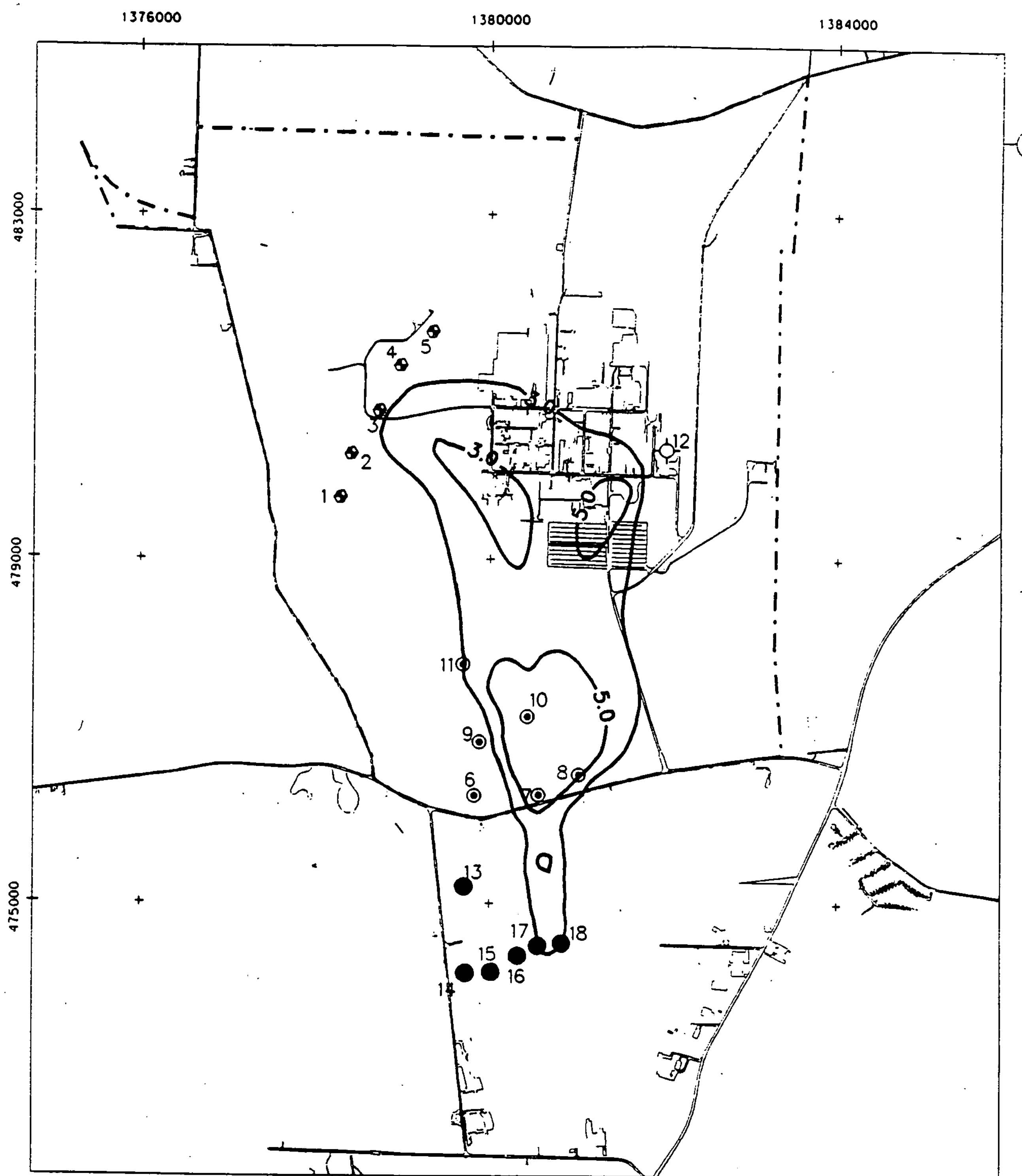


FIGURE 9-1. SCENARIO 1 (RESTORATION TO 20 ppb), WELL LOCATIONS



LEGEND:

FEMP BOUNDARY

3.0 CONCENTRATION CONTOUR (ppb)

SYSTEM 1 EXTRACTION WELL

SYSTEM 2 EXTRACTION WELL

SYSTEM 3 EXTRACTION WELL

SYSTEM 4 EXTRACTION WELL

SCALE

1750 875 0 1750 FEET

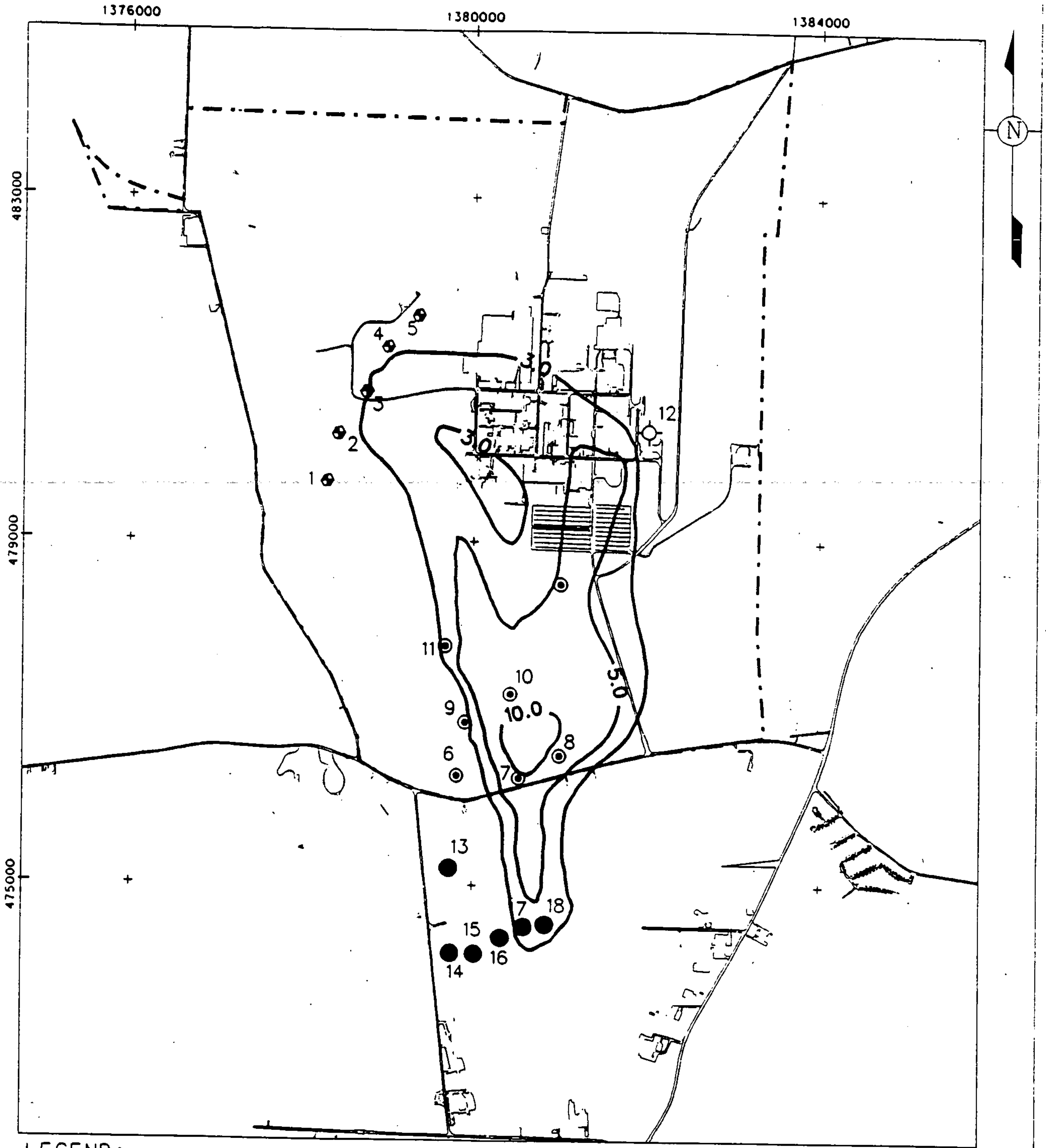
/USR/ERMA1/CRU5/DGN/C5SPSO11.DGN

DRAFT

MAX. CONC. = 9.02 ppb

FIGURE 9-2. SCENARIO 1A, URANIUM CONCENTRATION CONTOURS, YEAR 40, LAYER 1

[redacted]



LEGEND:

- · - · — · · FEMP BOUNDARY
- SYSTEM 1 EXTRACTION WELL
- SYSTEM 2 EXTRACTION WELL
- SYSTEM 3 EXTRACTION WELL
- SYSTEM 4 EXTRACTION WELL

MAX. CONC. = 12.31 ppb

—— 3.0 —— CONCENTRATION CONTOUR (ppb)

SCALE

1750 875 0 1750 FEET

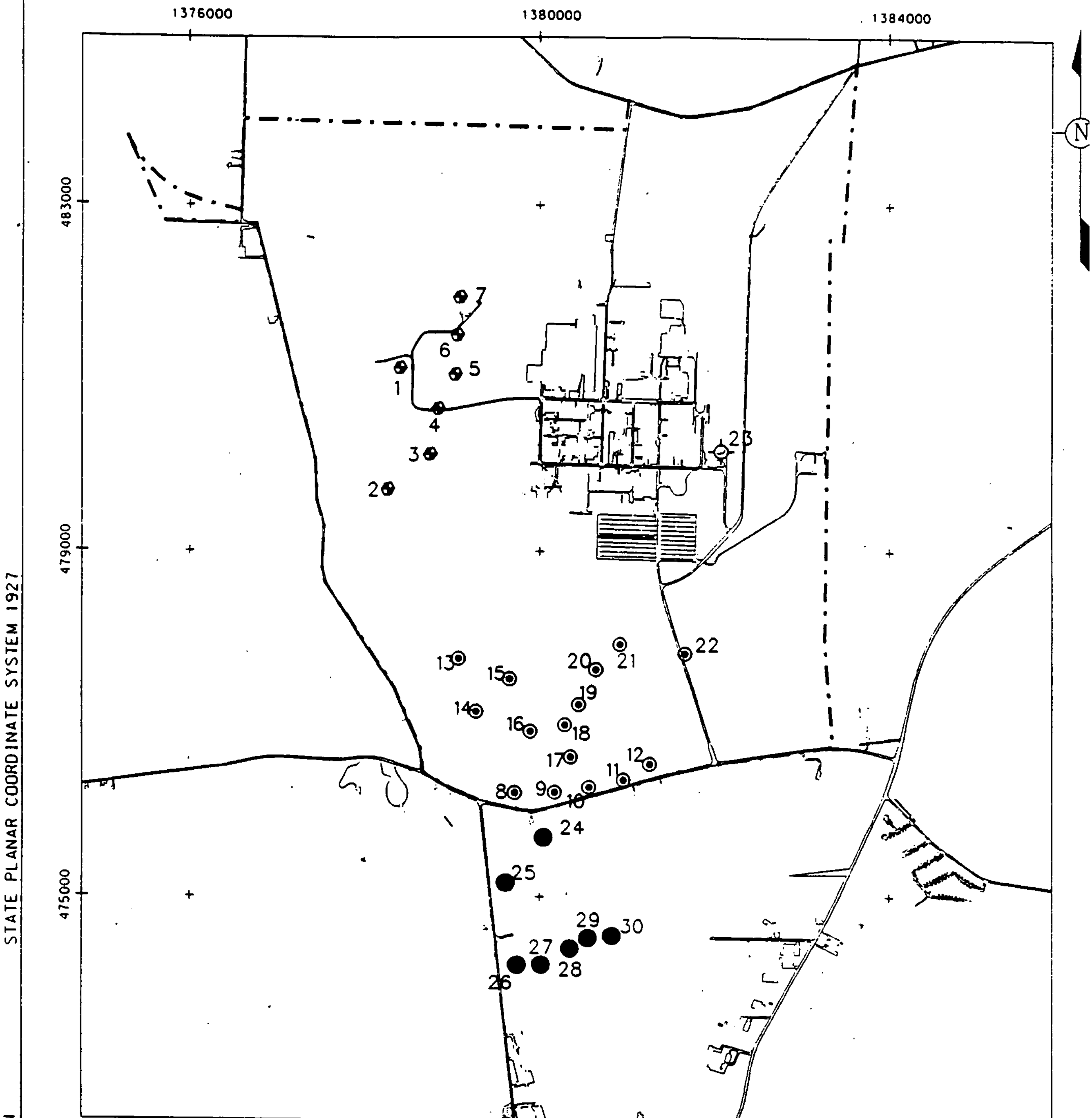
/USR/EMRA1/CRU5/DGN/C5PSP012.DGN

DRAFT

FIGURE 9-3. SCENARIO 1B, URANIUM CONCENTRATION CONTOURS, YEAR 40, LAYER 1

[redacted]

[redacted]



LEGEND:

FEMP BOUNDARY

SYSTEM 1 EXTRACTION WELL

SYSTEM 2 EXTRACTION WELL

SYSTEM 3 EXTRACTION WELL

SYSTEM 4 EXTRACTION WELL

SCALE

1750 875 0 1750 FEE

/USR/ERMA1/CRU5/DGN/C5PSP004.DGN

DRAFT

FIGURE 10-1. SCENARIO 2 (RESTORATION TO 20 ppb), WELL LOCATIONS

000119

[redacted]

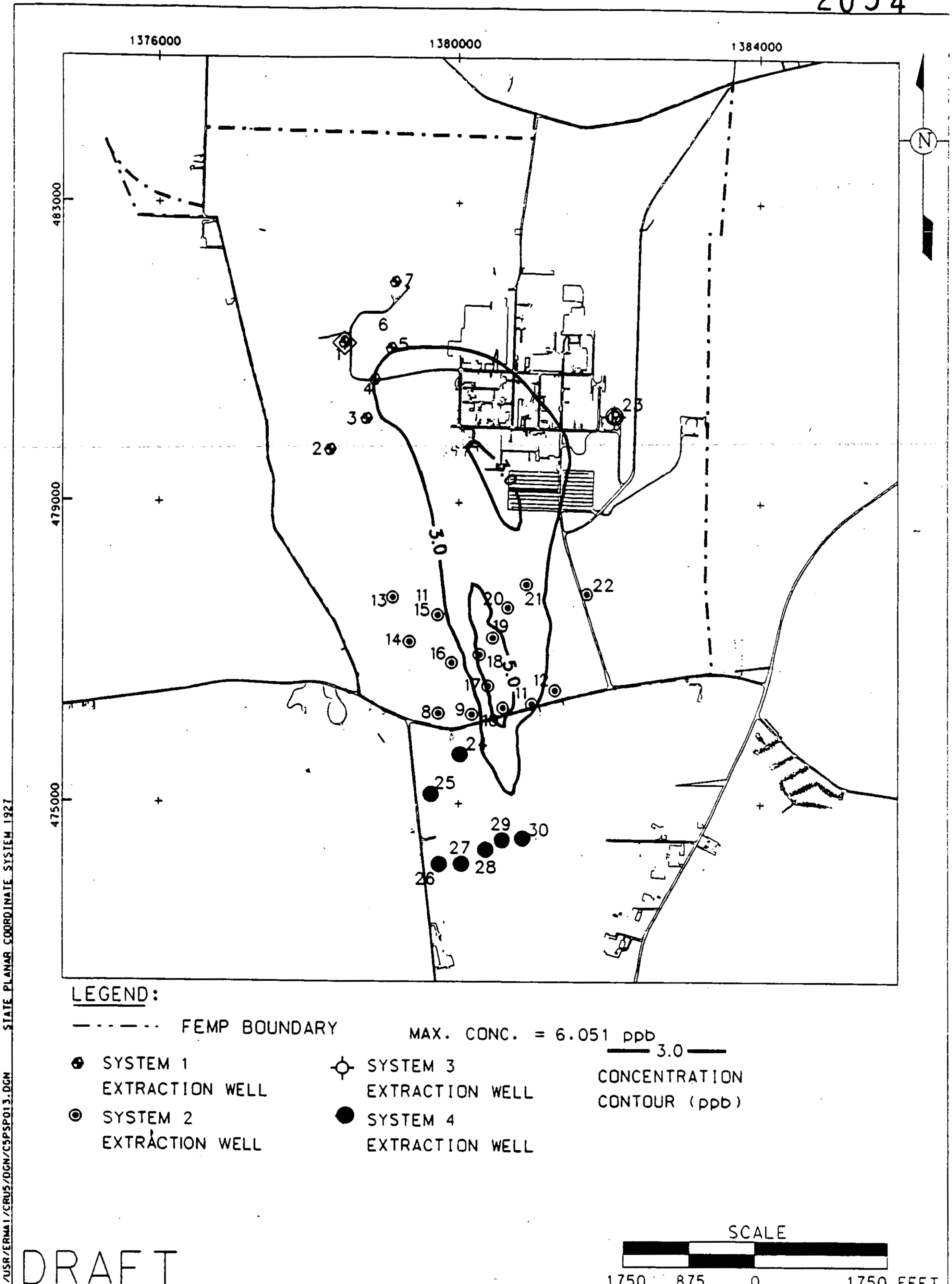


FIGURE 10-2. SCENARIO 2A, URANIUM CONCENTRATION CONTOURS, YEAR 40, LAYER 1

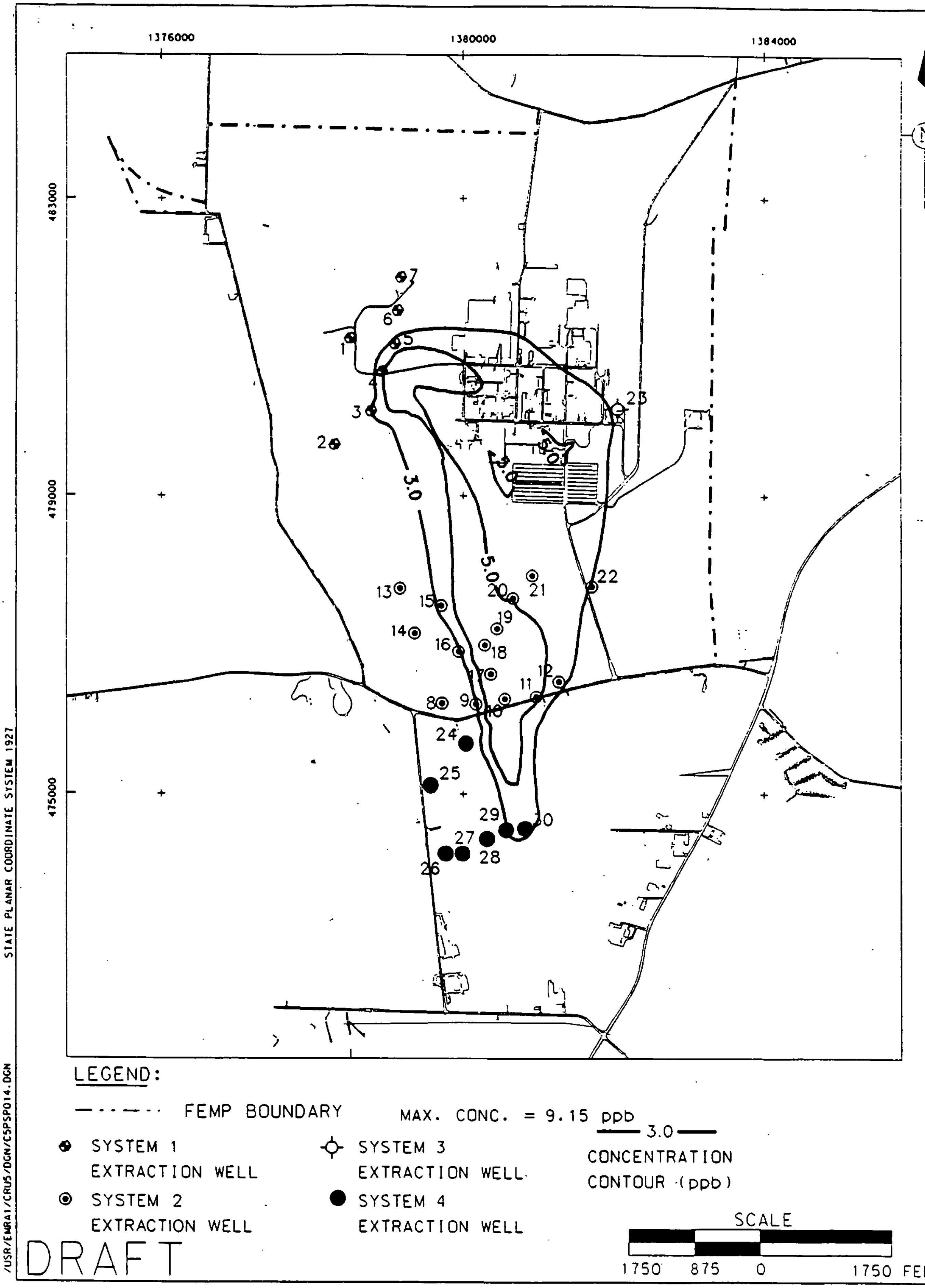


FIGURE 10-3. SCENARIO 2B, URANIUM CONCENTRATION CONTOURS, YEAR 40, LAYER 1

000121

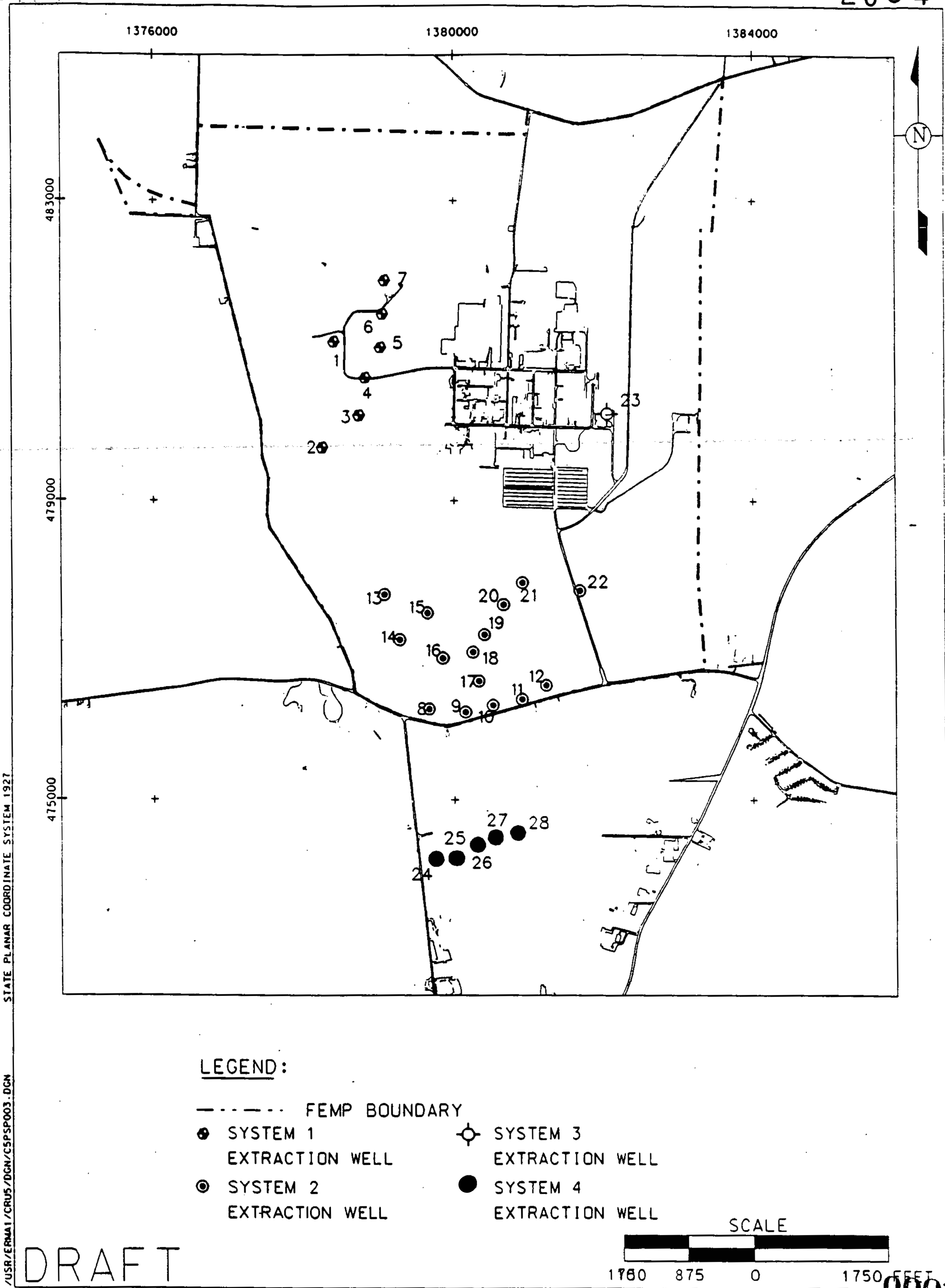


FIGURE 11-1. SCENARIO 3 (RESTORATION TO 20ppd), WELL LOCATIONS

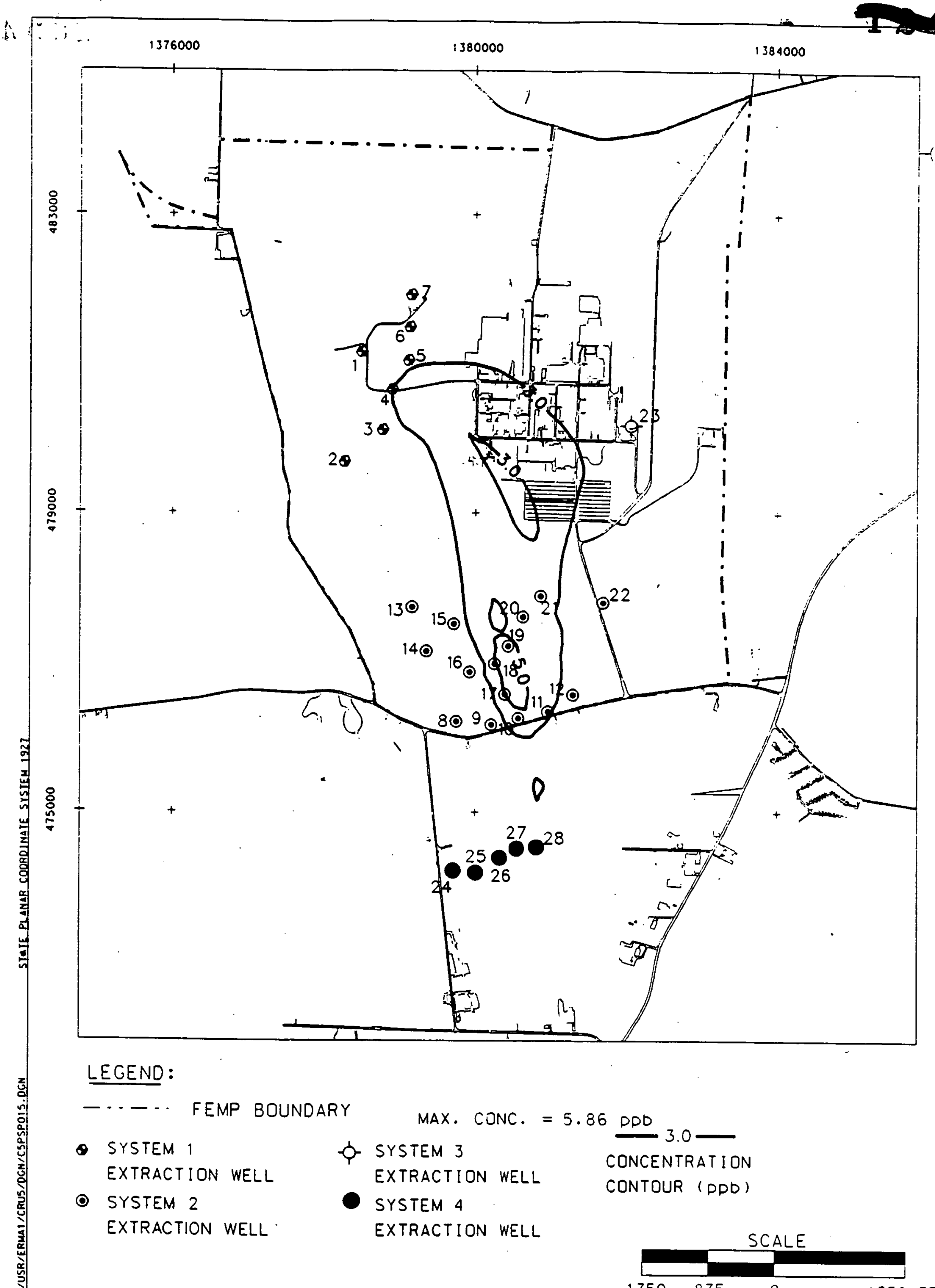


FIGURE 11-2. SCENARIO 3A, URANIUM CONCENTRATION CONTOURS, YEAR 40, LAYER 1

000123

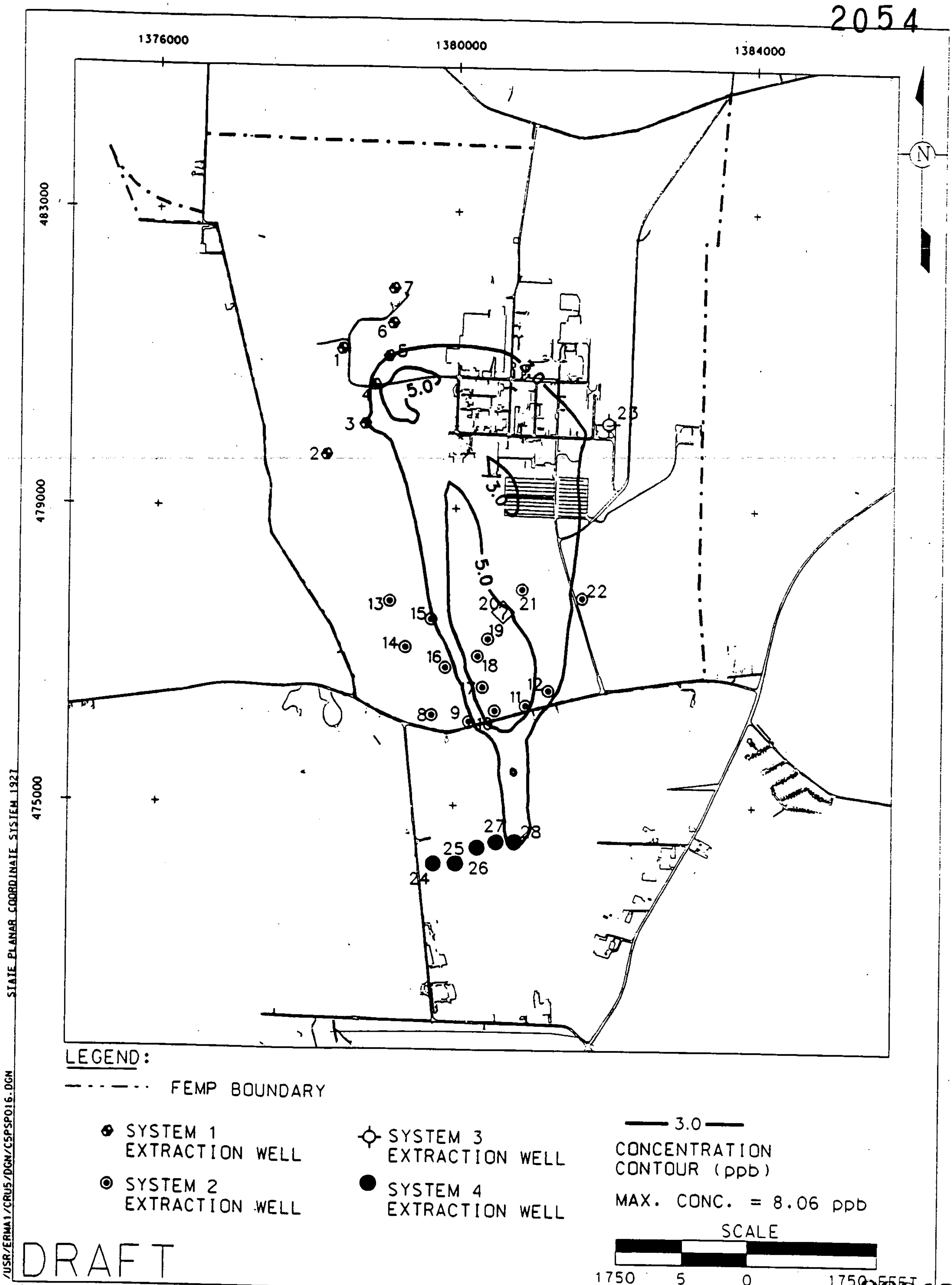


FIGURE 11-3. SCENARIO 3B, URANIUM [redacted] CONCENTRATION CONTOURS, YEAR 40, LAYER 1

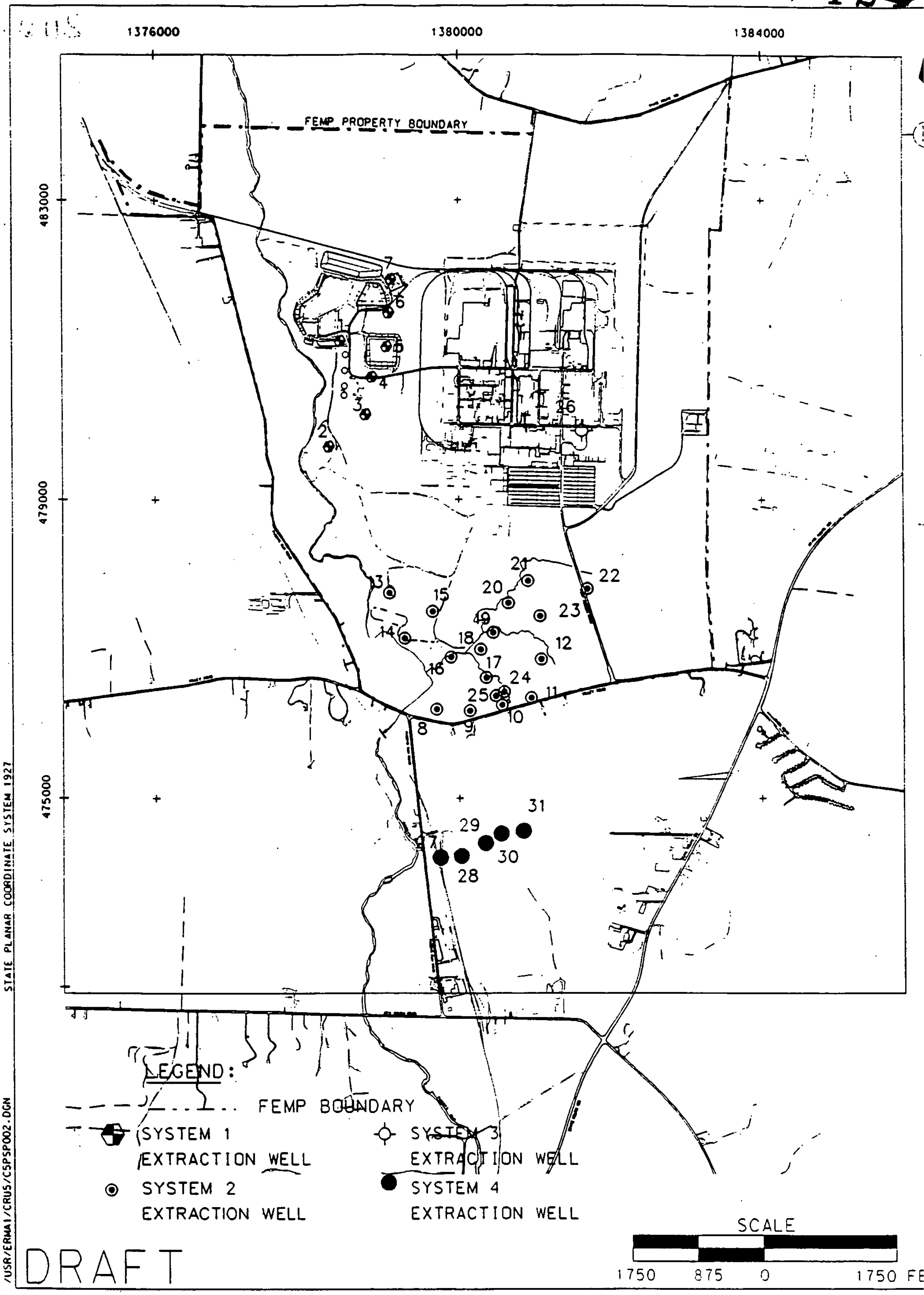
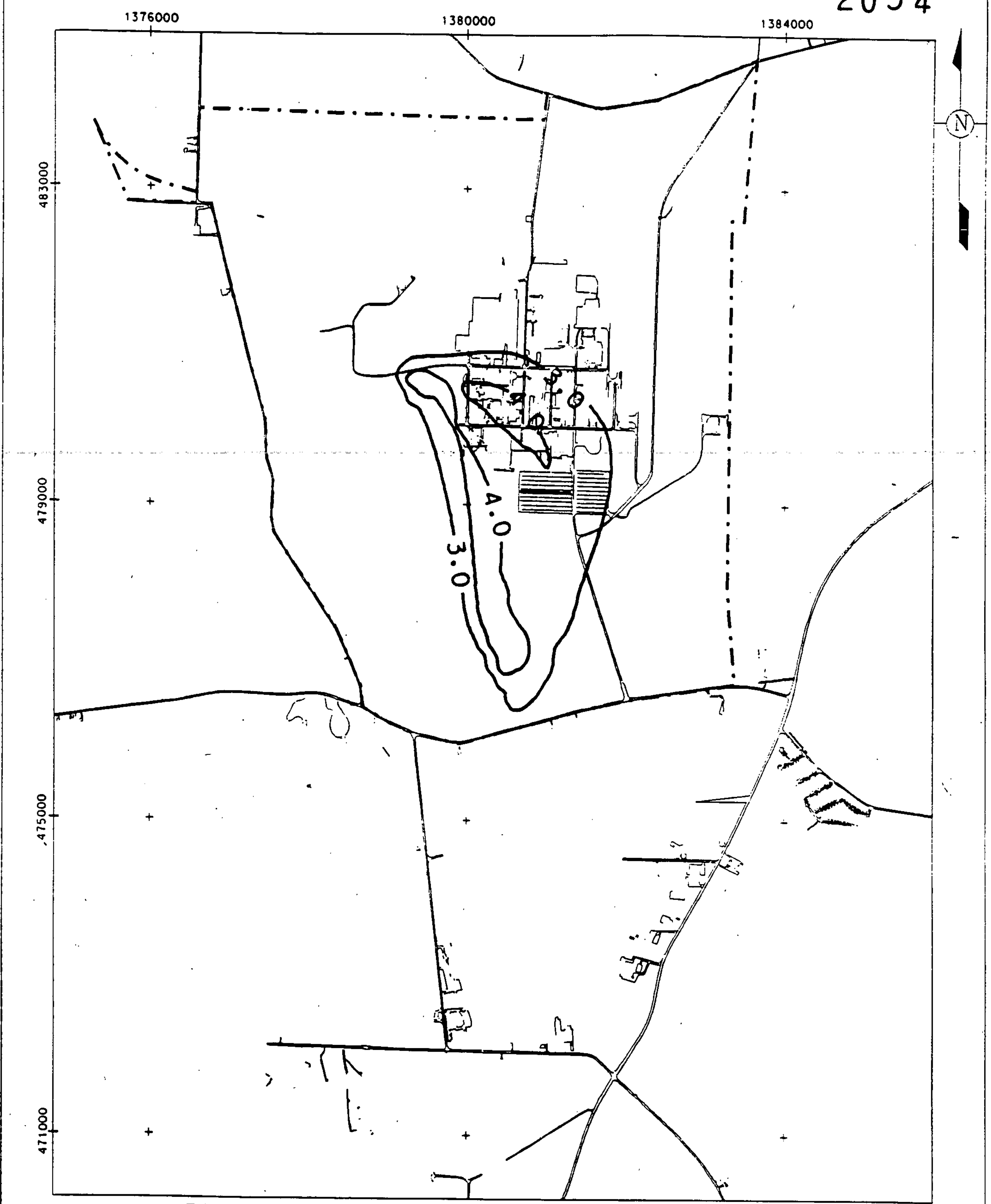


FIGURE 12-1. GROUNDWATER RESTORATION TO 3 PPB. WELL LOCATIONS

2054



LEGEND:

— · · — · · FEMP BOUNDARY

——3.0—— CONCENTRATION CONTOUR (ppb)

MAX. CONC. = 4.567 ppb

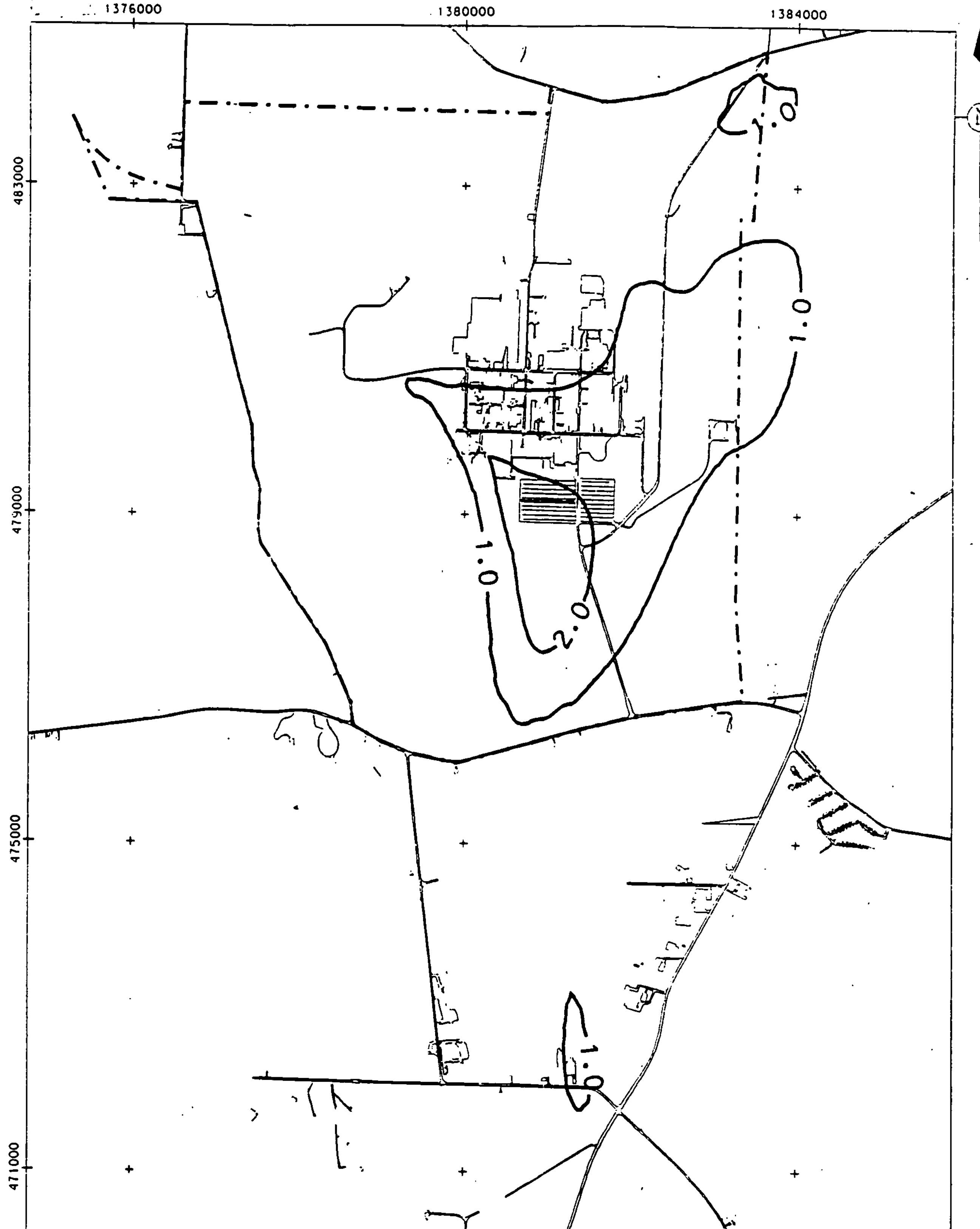
SCALE

1750 875 0 1750 FEET

DRAFT

FIGURE 12-2. GROUNDWATER RESTORATION TO 3 ppb. CONCENTRATION CONTOURS, YEAR 40 LAYER 1

000126



/USR/ERMA1/CRUS/DGN/C5SP021.DGN   STATE PLANAR COORDINATE SYSTEM 1927

LEGEND:

— · · — · · FEMP BOUNDARY

——— 3.0 ——— CONCENTRATION CONTOUR (ppb)

SCALE

1750 875 0 1750 FEET

DRAFT

FIGURE 12-3. GROUNDWATER RESTORATION TO 3 ppb, CONCENTRATION CONTOURS, YEAR 70, LAYER 1

[redacted]